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Concrete Arch Bridge with Ornamental Tile Panels, Philadelphia

By Jonathan Jones*

The city of Philadelphia has just completed a concrete arch bridge which, while it presents no structural features that are not standard in that city, is unusual in the prominence given to colored-tile panels, inserted in the concrete parapet, as a medium of decoration .

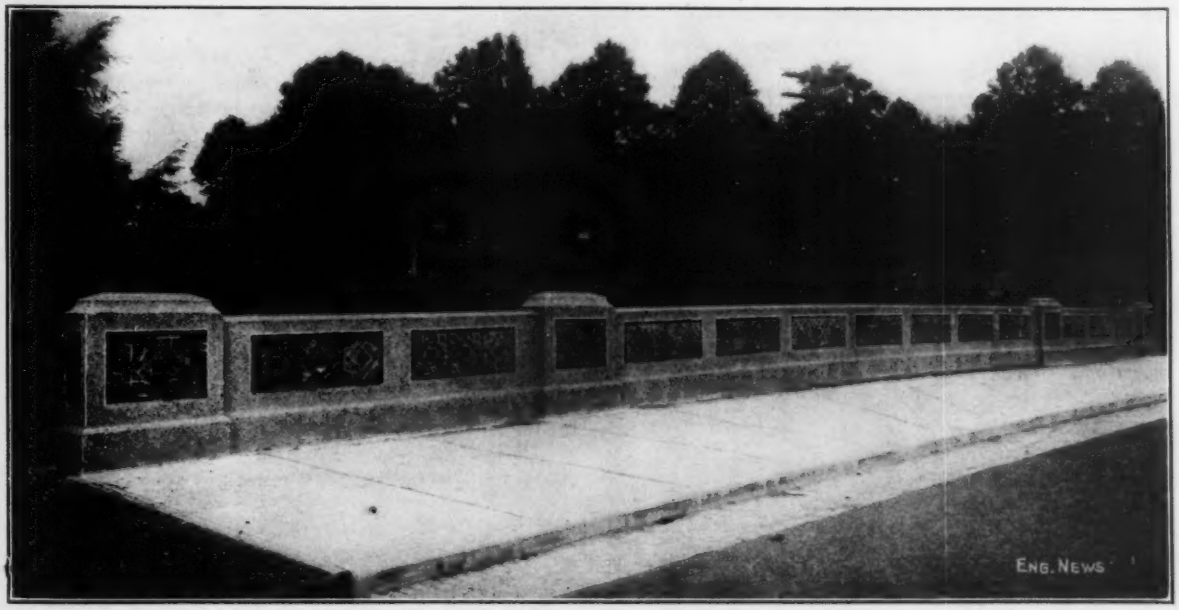

Fig. 1. Railing of 66th Ave. Bridge, Philadelphia, Showing Colored-Tile Inset

The bridge crosses the cut of the North Pennsylvania R.R., which for about a mile bisects the attractive residential district of Oak Lane. To provide for the considerable traffic which will take advantage of this crossing, and to accord with the type of dwelling characteristic of Oak Lane, this street, known at present as 66th Ave., is planned of 80-ft. width (50-ft. cartway and two 15-ft. sidewalks) and the bridge is built of full street width.

The clear span is 40 ft. and the skew about 75°, making the span on bridge axis 41 ft. 6¼ in. The clearance over outer rail of the double-track railroad is 16 ft. and the soffit curve adopted is an ellipse of 8 ft. 10⅝-in. rise.

The bridge is designed to carry as live load a 40-ton truck on any part of the roadway and 100 lb. per square foot of sidewalk. No reinforcement is used in the arch, the thickness at crown being 24 in. and the maximum stress in the concrete, 500 lb. per sq.in. No hinges are used and the six buttresses into which the arch stress is delivered take bearing on footings of a micaceous gneiss. The arch ring concrete is 1:2½:5, with the maximum possible amount (about 30 to 40%) of one-man stone embedded normal to the line of arch pressure.

The wing walls are parallel with the street, and are completely severed from the arch ring and spandrels, to prevent cracks being occasioned by the motion of the latter. The vertical joint thus formed is lined with asbestos felt to insure a separation, and is concealed by the relief of the pilasters on each side of the span. This joint is waterproofed with a coal-tar membrane, and drained with a dry-wall backing.

The spandrel wall is also cast independently of the arch ring, and after the slacking of the centers. The parapet is of solid concrete, with light reinforcement in the top to take care of slight temperature movements in the arch ring and in the parapet. The simple lines of the parapet are well brought out by the views, also the sharpness of the edges and the rough texture of the surface, which was obtained by using a ¾-in. crusher-run stone and scrubbing the next day after pouring.

On the outside, the parapet panels are recessed in the 8-in. wall. On the inside, these sunk panels are replaced by flush panels of dull-glazed Grueby tile, principally of terra

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cotta red and some dark green and blue. The proportion of tile here used, with the simplicity of the concrete in which it is set, makes the tile the distinctive feature of the design.

To insure the permanency of these tile inserts, it was at first intended to cast them as 3-in. reinforced slabs at the tile setter's shop, then to support these slabs in the parapet forms and concrete them solidly in place. Because, however, of the extreme difficulty of so supporting these heavy slabs as to obtain a perfect vertical curve from end to end of the bridge, and also because to wait for the slabs to cure would have delayed the concreting of the parapet until cold weather, it was decided to leave recesses in the concrete and set the tiles by the piece.

FIG. 2. NEAR VIEW OF TILE IN PLACE

FIG. 3. PILASTER WITH SUBSURFACE PREPARED FOR COLORED TILE

Accordingly, a 3-in. recess was boxed in the concrete, and the box was left in place over winter as a protection to the edges, the bridge being thrown into use as soon as the back filling was completed. Clamps of ¼-in. rods were cast in the parapet, as shown in Fig. 3, projecting into the space left for the tile backing. In the spring, when all danger from frost was over, the concrete was roughened and the clamps were laced at random with wire and the recess then filled with cement mortar to within 1 in. of the finished surface, as many panels being filled in a day as the tile setters could finish the next day. By this precaution it is felt that the slab of new material is locked to the older concrete without any reliance on adhesion, of which, however, considerable was obtained, and that in turn the tile are an integral portion of the new slab.

As there are in Philadelphia some examples of exterior tile work laid fifteen years ago with less refinement of method, it is not feared that frost or other agencies will dislodge these ornaments. To finish, the tile were pointed with neat cement, scrubbed with weak acid to remove cement stains, washed free of acid and coated with linseed oil.

The bridge was designed and the construction controlled by the Bureau of Surveys, Department of Public Works, George S. Webster, Chief Engineer; Richard Walsh was the general contractor, and the Wm. Moore Co., subcontractor for the tile work.

Some Gas-Explosion Experiments Leading to the Possibility of a New Floating-Piston Pump

BY C. J. BARTON†

The gas-explosion experiments described below were performed in the mechanical laboratories of the University of Michigan during the spring of 1912, to see how efficient an explosion of gas and air could be made without compression of the charge previous to the explosion. The equipment used consisted of a constant-volume-explosion apparatus slightly altered to adapt it to these particular experiments. It consisted of a mixing chamber (with city-gas, water, air and sewer connections) where the desired proportions of air and gas were mixed at atmospheric pressure. An inlet tube led from this to the explosion chamber for the transfer of a charge. The explosive mixtures used consisted of one volume of city gas and six volumes of air, as this proportion gave the greatest

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pressure when exploding at constant volume. Knowing the volume of the explosion chamber and the proportions of the mixture, the amount of gas burned during the explosion could be found (one seventh of total amount in the explosion chamber with the above mixture). The B.t.u.'s in the city gas ran about six hundred, which gave a pretty accurate method of figuring the total amount of heat available for work during the explosion. To get the actual amount of work done during the explosion, a U-shaped pipe was fitted to the explosion chamber and in it a known amount of water was poured before each explosion. The force of the explosion was expended in shooting the water out of the nozzle at an angle of 45° with the horizontal. Knowing the weight of the water placed in the nozzle and the velocity of the water as it left the nozzle the kinetic energy of the water as it left the pipe would be equal to one-half the mass times the velocity squared; neglecting the slight friction losses in the nozzle this energy would be equal to the work done on the water by the force of the explosion. The water, as it left the nozzle, took the path of a parabola and fell some distance out from the nozzle. The velocity of the water as it left the nozzle was easily computed after measuring the horizontal distance from the end of the nozzle to the floor where the water hit. The formula used was*

$$V = \sqrt{\frac{32\,s^2}{h + s}}$$

where V = velocity of water leaving nozzle in feet per second; s = horizontal distance from the floor beneath the nozzle to where the water hit, in feet; h = vertical distance from end of nozzle to floor, in feet.

Having found the nozzle velocity in feet per second, as above described, the work expended upon the water by the force of the explosion was found in foot-pounds by multiplying one-half the mass of the water by the velocity squared, dividing this result by 778 to change to B.t.u.'s, then dividing by the B.t.u.'s available in the gas burned during the explosion and multiplying by 100 gives the per cent. efficiency of the explosion.

The earlier experiments showed an efficiency of from 4 to 5%. Later, as the apparatus was improved and more suitable amounts of water were used, results showed an efficiency of over 10%.

The explosions were noiseless, the expansion being carried down to or below atmospheric pressure in ejecting the water from the nozzle as indicator cards taken of the explosions plainly showed.

There is no doubt that with improved experimental apparatus and further investigation along this line, the best results obtained by the writer could be surpassed. An efficiency of 10% surpasses the thermal efficiency of many two-cycle explosion engines now in operation and compares favorably with the thermal efficiency of many four-cycle engines under working conditions.

The success of the Humphrey gas pump has shown the possibilities of the liquid piston. Perhaps the cited results of these experiments might tend to show some commercial possibilities of a liquid piston-pumping engine which does not use compression of the charge previous to explosion. The possible advantages of such a liquid-piston pump over one of the Humphrey type would be the small initial cost and larger capacity—due to the greater number of explosions per minute. The Otto Langlen Gas Engine is a notable example of a type of gas engine which did not use compression previous to the explosion of the charge. The thermal efficiencies of the different tests of this engine ran from 14 to 17%, which compares favorably with the government tests of modern four-cylinder four-cycle engines which use compression previous to ignition of the charge.* This compression lowers the

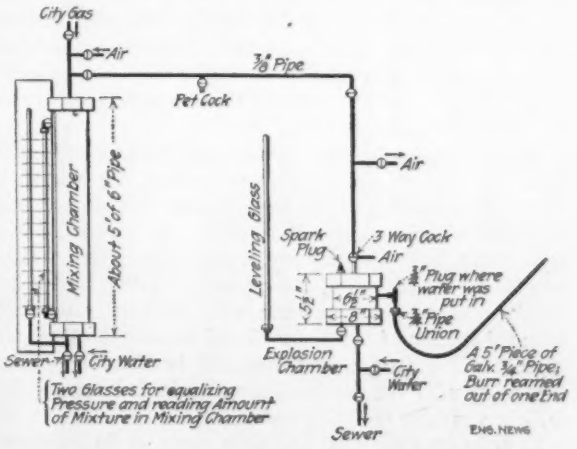


DIAGRAM OF GAS-EXPLOSION APPARATUS

mechanical efficiency and introduces thermodynamic losses.

The effect of the rate of expansion upon the efficiency of explosion is interesting. Take the two limiting cases of explosions—the first at constant volume, where the mechanical work done by the explosion is nothing and the efficiency is zero because the space is nothing.

The other limiting case is where the force becomes zero. This is illustrated by an explosion at atmospheric pressure. The force of the explosion is almost completely unrestrained, the work and efficiency of the explosion in this case is almost zero. Assume that the explosion is completely unrestrained, as would be the case if the theoretical piston could move out as fast as any increment of pressure is generated behind it, while the flame is propagated through and combustion takes place in the exploding mixture; then the force, the work done, and the efficiency of the explosion will all be zero.

The most efficient explosion will undoubtedly lie between the two limiting cases. The indicator card of the

*If V_y and V_x are the vertical and horizontal components of V, T is the time, in seconds elapsed between water leaving nozzle and reaching floor, and e is the nozzle angle with the horizontal.
Then

$$s = V_x t = V \cos e\, T$$
$$h = g/2\, T^2 - V_y T$$
$$= g/2 \frac{s^2}{V^2_x} - V_y \frac{s}{v_x}$$
$$= g/2 \left[\frac{s}{v \cos e}\right]^2 - \frac{V \sin e}{v \cos e} s$$
$$= g/2 \frac{s^2}{v^2 \cos^2 e} - s \tan e$$

For 45°

$$h = \frac{g s^2}{V^2} - s$$
$$V^2 = \frac{g s^2}{h + s}$$
$$V = \sqrt{\frac{32 s^2}{h + s}}$$

*Some later tests, reported by the Society of Automobile Engineers, on 30-hp. motors, showed thermal efficiencies running from 6 to 12%. With 85% mechanical efficiency, the overall figure would range from 5 to 10%.

first would be represented by a straight vertical line. The indicator card in the second case would be represented on the pressure-volume diagram by a horizontal line. Theoretically, the most efficient indicator card for separate atmospheric explosions, not considering the great radiation loss during expansion, would be explosion at constant volume, followed by adiabatic expansion to atmospheric pressure.

There are so many variable factors entering here that it would be almost impossible to determine just what rate of expansion would be most efficient. It was determined experimentally in the following manner. The mixing chamber contained enough charges for several explosions; by using the same mixture for a number of explosions and keeping other conditions the same, the amount of water used in the nozzle was varied from a small to a large amount. It was found that 700 c.c. of water gave the greatest efficiencies for this particular apparatus. The smaller amounts would be shot further but not enough further to make the work done on the water as great as if the larger amount was used. Amounts of water over 700 c.c. would not be shot as far and the work done on the water would figure out to be less. Still larger amounts of water would almost completely deaden the explosion, the greater inertia of the larger mass of water would greatly retard the expansion of the charge to the extent that the bulk of the available energy was lost in radiation as heat.

By regulating the amount of water discharged each time, the pump could be made to operate at a rate such that the expansion would occur under conditions most favorable for the greatest efficiency. A further advantage of the liquid-piston pump of this possible type is that less time elapses during the expansion with the continuously accelerated piston than with the accelerated and retarded motion of the piston found in reciprocating gas engines. The longer time required to make a certain expansion with the accelerated and retarded motion results in a greater radiation loss.

In glancing over some late tests made on 30-hp. automobile motors reported by the S. A. E., the thermal efficiencies ran from 6 to 12%. Assuming a mechanical efficiency of 85%, the overall percentage would range from 5 to 10%. The overall efficiency of explosion apparatus not using compression previous to ignition ranged from 5 to 10%. This is the reason that I made the statement that I thought the experiments would warrant the commercial application of the principle involved in these experiments to liquid-piston pumping apparatus.

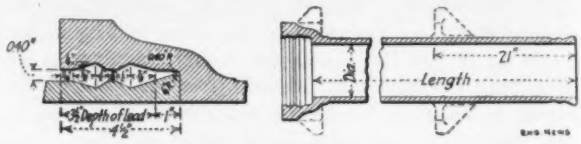
The New High-Pressure Fire-Service System of Boston

(CONTRIBUTED)

Boston was one of the first cities in the United States to lay a separate pipe line solely for fire-protection purposes, about one mile of such pipe having been laid in 1898, to be supplied with salt water from the harbor by fireboats.

A general-alarm fire at Dover and Albany streets, on Aug. 9, 1910, required the use of 41 fire-engines, while at the same time 16 other engines were engaged at a second-alarm fire on High St. Fifteen engines from surrounding cities rendered aid and it was evident that, in this situation, the protection of the city as a whole, as well as that of adjoining municipalities, was seriously weakened. It appeared, therefore, that steps should be taken to guard against the dangerous possibilities of a like situation in the future. After full consideration, the installation of a high-pressure fire-service system was adopted as the best and most practicable solution of the problem, in that it would furnish the most reliable form of protection to the high-value district, since it could deliver more water at high pressure than all the steam fire-engines now in the service of the city operated at one time.

The construction of such a high-pressure fire-service system became assured when a legislative act authorizing the Commissioner of Public Works to prepare the necessary plans and proceed with the construction was accepted by the city government. Upon the passage of an appropriation order by the City Council and its approval by the Mayor, on July 1, 1911, an engineering corps was organized as the High-Pressure Fire-Service Branch of



BOSTON FIRE-SERVICE

Pipe weights in pounds—see Fig. 1

Diam. of pipe, in.	Weight per ft. of barrel	Weight of bell	Lugs — Number	Lugs — Weight per set on bell	Lugs — Weight per set on spigot end	Length 3 ft. — Weight with lugs	Length 3 ft. — Weight without lugs	Length 4 ft. — Weight with lugs	Length 4 ft. — Weight without lugs	Length 6 ft. — Weight with lugs	Length 6 ft. — Weight without lugs	Length 12 ft. — Weight with lugs	Length 12 ft. — Weight without lugs	Weight of lead for standard joint
8	69.1	74	4	30	63	373	280	442	349	581	488	995	902	27
12	133.1	138	4	35	72	643	536	776	669	1041	934	1843	1736	39
16	215.3	219	6	50	126	1040	864	1255	1079	1686	1510	2978	2801	51
20	318.9	323	6	63	175	1515	1277	1834	1596	2472	2234	4385	4147	63

FIG. 1. JOINT FOR STRAIGHT CAST-IRON PIPE, NEW HIGH-PRESSURE FIRE SERVICE, BOSTON, MASS.

the Water Service and a consulting engineer for the pumping-station equipment was retained. The laying of the pipes has just been begun (August, 1914).

The area which will be protected by the system contains about 550 acres, comprising the whole of the 335 acres which the Underwriters term the congested-value district and adjacent territory through which it is necessary to lay pipe to serve the high-value area. For the protection of a district of this character, the capacity of the system should be such that 20,000 gal. of water per min. can be delivered about any block and 10,000 gal. of water per min. on any single building, and the system has been designed to meet these requirements.

The location of the pumping station has not yet been determined definitely, although it is very probable that it will be near Fort Point Channel, in the vicinity of the South Terminal Station, where it will be out of reach of a great conflagration. New mains will run to the station to supply the water needed for the high-pressure service, which must be ample in amount.

Motor-driven centrifugal pumps have been selected as the most reliable and economical type of equipment to install. Electrical energy will be supplied, over duplicate circuits, from the power plants of the Edison Electric Illuminating Co. Each pump will be capable of delivering

3000 gal. per min. at a pressure of 300 lb. per sq.in. Separate fireproof rooms containing the high-voltage electrical apparatus will be located in the rear of a switch-

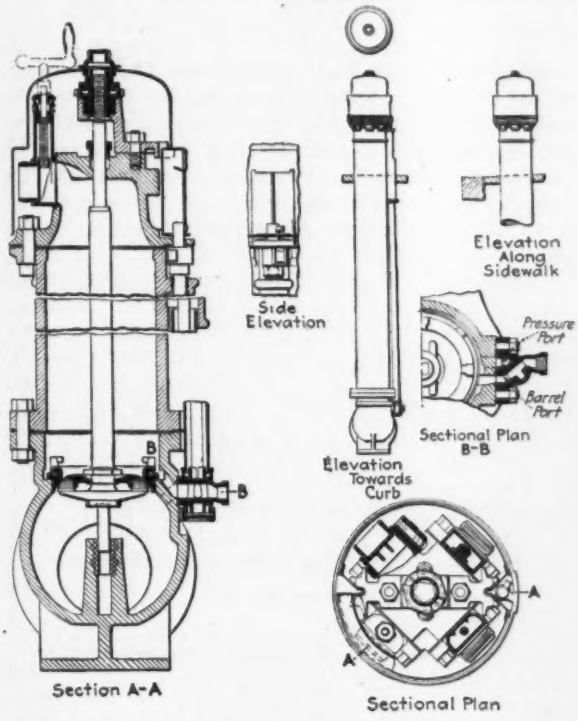


FIG. 2. HYDRANT FOR NEW HIGH-PRESSURE FIRE SERVICE, BOSTON, MASS.
(Patent applied for by J. A. Rourke*.)

board from which the pumps and motor-operated valves will be controlled. Fire alarms and orders from the Fire Department will be received over a fire-alarm circuit and a separate signal system which will be installed. Telephone service, over dupicate wires, will be provided by the telephone company.

A duplex distribution system, composed of two independent pipe systems with their mains on alternate streets, has been designed, thus insuring continuity of water-supply in case of the failure of a main in either leg of the system. About 13 miles of pipe, from 12 to 20 in. in diameter, will be required to build the system and cast iron has been selected as the best material for the purpose.

The first high-pressure systems were laid with steel pipe but cast iron was quite generally adopted later, flanged joints being used. Such joints occupy considerable space and are undesirable in streets so crowded with underground structures as are those of Boston. The selection of a bell-and-spigot pipe of special design, the details of which are shown in Fig. 1, followed an exhaustive series of tests on pipes and joints made by the Public Works Department. These tests included joints made with lead and with various alloys of lead, antimony and tin. It was found that an alloy consisting of 96% lead and 4% antimony afforded the necessary holding strength, but that a tight joint could not be made with it. The best results were obtained with 96% lead, 2% antimony and 2% tin, a joint resulting which held a pressure of 600 lb. per sq.in. on a 20-in. plug with no leakage. This alloy was therefore adopted for all joints adjacent to branches, offsets, bends and dead ends where holding strength is necessary. The specifications require that the alloy shall be made by melting the lead in a large pot, adding the proper proportion of antimony, previously melted in a separate pot, and then adding the tin.

All pipes, after laying, are to be tested by water pressure at 400 lb. per sq.in. and the leakage must not exceed ½ gal. per lin.ft. of pipe joint per 24 hours.

The mains will be so equipped with gate valves that a break in a pipe will necessitate putting out of service not more than three hydrants and each valve will be set in a manhole large enough to permit of easy access for maintenance and repairs. The valves are of special design, made to suit the requirements of the service.

The hydrant adopted, shown in Fig. 2, was also designed in the Public Works Department. It is simple in design, reliable and efficient, and has a capacity of 2000 gal. per min., which is equivalent to that of three fire engines. Each hydrant will be set on a branch provided with a gate valve, as shown in Fig. 3, thus providing for cutting out any hydrant without affecting the flow in the mains. About 450 hydrants will be placed within the area covered by the system, or about one hydrant to each 40,000 sq.ft. of area, which will enable the capacity of the system to be concentrated where needed through hose lines of moderate length.

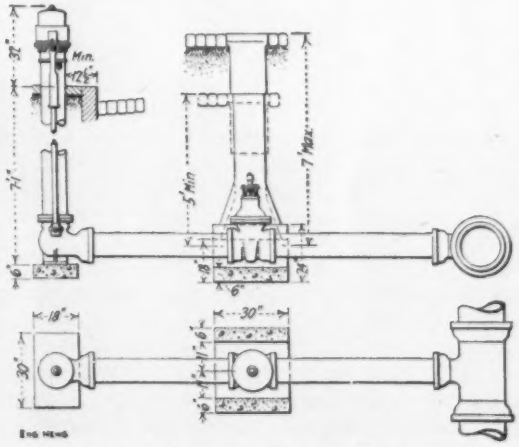


FIG. 3. GENERAL ARRANGEMENT OF HYDRANT SETTING, BOSTON HIGH-PRESSURE FIRE SERVICE

The congestion of underground structures in the narrow streets makes the work of laying the high-pressure pipe very difficult. To enable the work to be done to the best advantage and at a minimum expense, plans have been made, based on a transit survey, showing all existing structures and enabling the selection of the most feasible locations.

The high-pressure fire-service system will enable a large number of powerful streams to be concentrated on a fire in a shorter time than with fire engines, and with much fewer men and less apparatus. This will, in turn, enable the protection of the remainder of the city to be maintained during the progress of a fire in the district covered by the system in addition to providing ample protection to the highest values in the city during the progress of a possible conflagration in the congested, frame-structure, residential districts.

*J. A. Rourke is Mechanical Engineer, High Pressure Fire Service, of the Public Works Dept. of Boston.

The New Girard Point Grain Elevator at Philadelphia

By S. Ingberg*

SYNOPSIS—The new Girard Point grain elevator of the Pennsylvania R.R. at Philadelphia has concrete bins, with a total capacity of 1,078,700 bushels. The foundation consists of piles covered with a huge reinforced-concrete slab, with a waterproofing course. The basement being below high-water level, the lower ends of the elevator boots are inclosed in steel tanks as an additional precaution against water. All machinery is electrically operated. One of the interesting features of the article is the description of the way in which the grain is handled from the time it is received from cars until it is shipped for transportation.

A large terminal grain elevator for transfer and storage purposes has been erected at Girard Point, Philadelphia, for handling the export business of the Pennsylvania R.R., as the traffic overtaxes the present facilities. It is located at the mouth of the Schuylkill River, and was built for the Girard Point Storage Co., which is a subsidiary of the railway company.

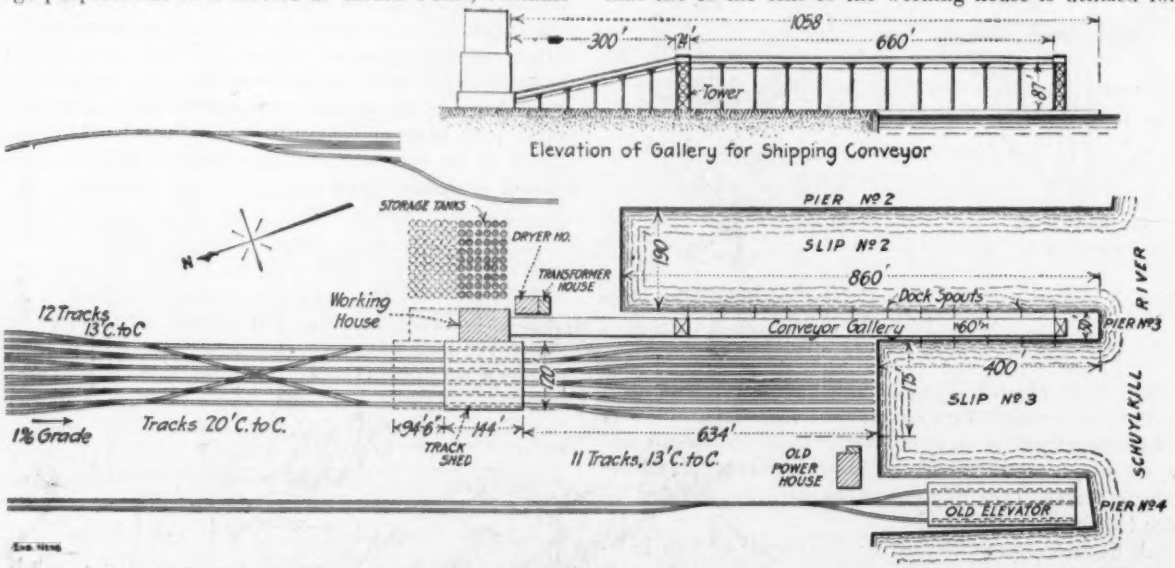


FIG. 1. PLAN OF NEW GRAIN ELEVATOR AT GIRARD POINT, PHILADELPHIA, FOR THE PENNSYLVANIA R.R.

The general plan of the plant is shown in Fig. 1, and Fig. 2 is a view of the buildings when practically completed. The cross-section and plans in Fig. 3 show not only the design and construction, but show also the arrangement of the conveyors and other apparatus for handling, weighing and distributing the grain. The loaded cars are delivered to a large yard (at the left of Fig. 1) having 12 tracks, spaced 13 ft. c. to c., and on a descending grade of 1% toward the elevator. These converge into six tracks extending to the elevator.

The track shed, where the grain is delivered from the railway cars, is 120x144 ft., with six tracks spaced 20 ft. c. to c. Adjacent to this is the working house 62x94 ft., from which a conveyor bridge extends along the dock to deliver grain to vessels. Above the first floor of this building are 24 cylindrical concrete bins 13 ft. diameter and 74 ft. high; and above these is the cupola, 62x82 ft., and 93 ft. high, containing the distributing machinery, etc. The storage house consists of 54 cylindrical bins 15 ft. diameter and 96 ft. high, surmounted by a working floor for the conveyor belts which deliver grain to the bins. Provision is made for increasing the size of the plant when required.

The working house, with its track shed and conveyor gallery, has a capacity for storing 240,000 bu., receiving 28,000 bu. per hr., shipping 60,000 bu. per hr. from the dock, and cleaning and separating 10,000 bu. per hr. The storage house has a capacity of 837,000 bu., and the dryer has a capacity of 3000 bu. per hr. It should be noted that one of the bins of the working house is utilized for a freight elevator and spiral stairway, and is not available for grain. The details of the bin capacity are as follows:

	Bu.	Bu.
Working house:		
23 circular bins	7,400	170,200
5 interstice bins	5,400	27,000
10 interstice bins	4,400	44,000
Total		241,200
Storage annex:		
27 circular tanks	12,900	348,300
27 circular tanks	13,200	356,400
24 interstice tanks	3,400	81,600
16 interstice tanks	3,200	51,200
Total		837,500
Grand total		1,078,700

Structural Features

The structures are of reinforced-concrete throughout, with the exception of the steel gallery for the dock conveyors. Borings at the site showed about 50 ft. of mud and clay, followed by gravel and sand to about 60 ft., with rock at two points 64 ft. and 104 ft. from the surface. The foundation is a reinforced-concrete slab (with side walls rising above water level), supported on wood piles 65 ft. long. These piles carry an average load of 16 tons,

*Structural Engineer, James Stewart & Co., Chicago.

and under the working house and the storage annex they are spaced 27 in. c. to c. in each direction.

The bottom foundation slab and foundation walls are waterproofed with a 6-ply felt membrane cemented with a pitch compound. This membrane extends 6 in. above the extreme high-water line; it is underlaid with 9 in. of concrete and on the outside of the walls it is protected by 5 in. of brick. As a further precaution against the water, which at times comes 3 ft. above the basement floor, there is a system of inside drains laid in the basement slab and emptying into the boot pits. In the latter, one on each side of the house, is located a sump served by an automatic motor-driven pump, the operation of which is controlled by a float. This, with the use of water-tight steel tanks around the boots, is thought to insure the operation of the elevator during periods of extreme high water and to prevent stagnant water from collecting in any portion of the building.

THE WORKING HOUSE—Fig. 4 shows the construction of the slab under the working house. The depressions for the boot tank (8½ ft. on the receiving side and 6¼ ft. on the shipping side) were filled with sand after the steel tanks were placed, and the fill covered with a 4-in. concrete slab.

Fig. 4 shows also other details of the working house, a cross-section of which is given in Fig. 3. Its columns (the larger of which are loaded to 1,500,000 lb.) are reinforced with spiral hooping and vertical rods, as are also those in the first story. The latter are shown in Fig. 4, together with a plan of the girders and slab supporting the bins. The walls of the bins are 6 in. thick (7 in. on the exterior side of the outer bins). The reinforcement consists of vertical bars and horizontal hoop bands, the latter spaced 12 in. vertically. Each band consists of two semicircular bars, with overlapping ends, the bands breaking joint in the several courses.

THE STORAGE ANNEX—This building (at the right in Fig. 3) has its bins or tanks supported on a 16-in. top foundation slab bearing on piers, two for each tank, as shown in the foundation plan on the same cut. The bottom slab, 4 ft. in total thickness, is reinforced with bands of bars in the top and bottom. The bands in the bottom are laid in two directions and under the piers, while those in the top are laid in four directions, directly and diagonally between the piers. The 16-in. upper slab has four-way reinforcement, supplemented by circular bands around the openings for the draw-off hoppers at points of maximum tension and compression. The bottom foundation slab was made heavier than the stress requirements would demand, on account of the desirability of placing the basement floor above mean high water without the use of a false floor.

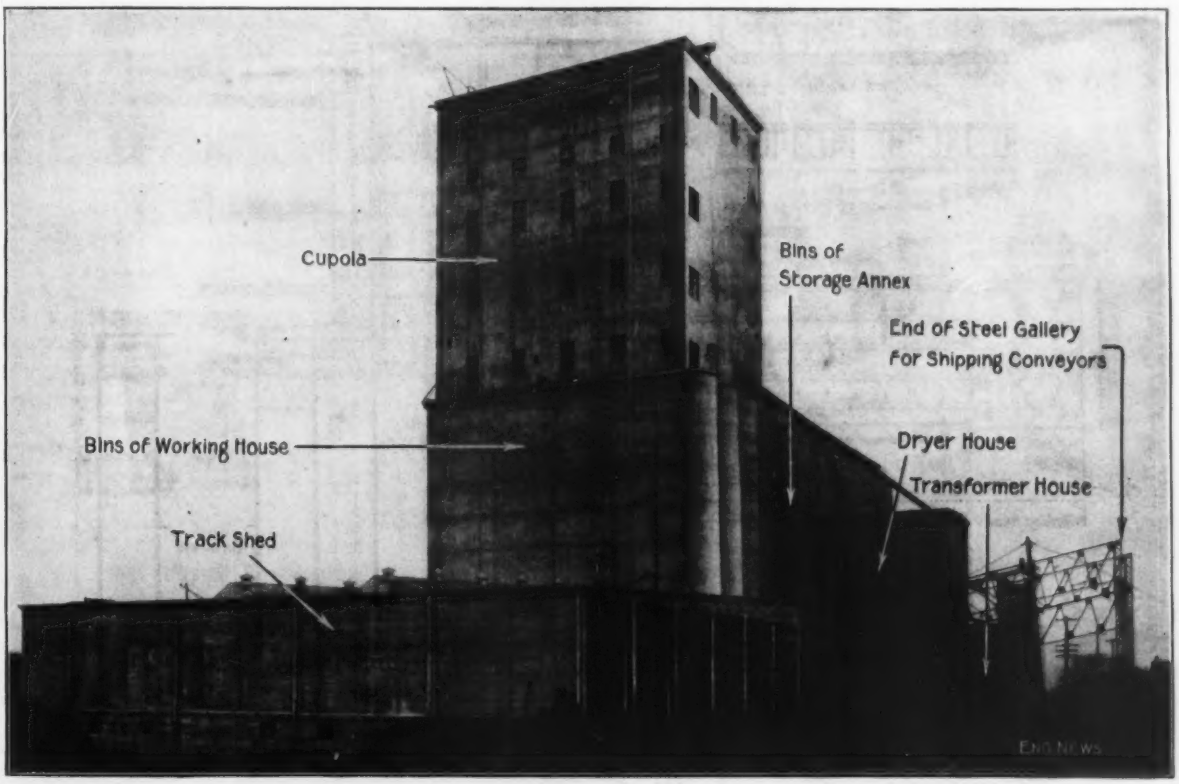


FIG. 2. COMPLETED BUILDINGS OF THE GIRARD POINT GRAIN ELEVATOR

The circular reinforcement for the tanks consists of flat bars (1x¼-in. to 1x⅛-in.), spaced 12 in. apart. Each band is made up of two lengths, lapping 3½ in., each band breaking joints with those above and below it. No mechanical means are employed for bonding the two pieces other than the concrete, which has a minimum thickness of 1½ in. between the bars and with a fair unit-bond stress forms an efficient joint.

FORMS—The bins and the working-house cupola were built with moving or sliding forms. These are composed of vertical staves 4 ft. high, nailed to circular chords made up of 2x8-in. planks cut into segments. They are

moved up by screw jacks working on the vertical jacking bars embedded in the bin walls. The jacks and yokes are shown in place in Fig. 5. This method of forming is not only found to effect an economy in time and expense, but also to give a smoother surface than is ordinarily obtained with stationary form work.

Conveyor Bridge—The bridge or gallery (Fig. 1) extending along the dock, and carrying the shipping conveyors, consists of an inclined portion 300 ft. long in six spans of 50 ft., leading up from the working-house gallery to tower No. 1, and a level portion between the towers 660 ft. long in 11 spans of 60 ft. In the towers are the motors and drives for the four 36-in. belt conveyors contained in each portion of the bridge. The general construction of the bridge is shown in Fig. 6. It has two side trusses, carrying the floor at their lower chords, and a center truss beneath the floor. The trusses are of similar design except at the end connections. The reactions of the center truss are carried into the columns by means of a triangular end truss consisting of double-channel struts riveted to the columns. This arrangement of trusses shortens the span of the floor-beams and leaves a clear space above the floor for the conveyors.

The floor-beams consist of 12-in. channels 7 ft. c. to c., and on these are laid the T-bars for receiving the book-tile floor (Fig. 6). The tiles are 3x12x18 in. and are covered with a 2-in. cement mortar finish. The roof is made similar to the floor except that the beams have angle flanges with laced web, and the book tile is covered with 1-in. mortar finish, on which is laid a 5-ply composition tar, felt and gravel roof. The sides are covered with No. 22 galvanized corrugated siding.

Construction Plant

Sand and gravel from barges in the slip are unloaded by a clam-shell bucket into a receiving hopper discharging onto a conveyor, as shown in Fig. 7. This leads up an incline to a maximum height of 45 ft. for discharging into the stock piles, the sand being discharged by a stationary tripper 40 ft. from the end of the belt where the gravel is discharged. Trains of 1-yd. charging cars

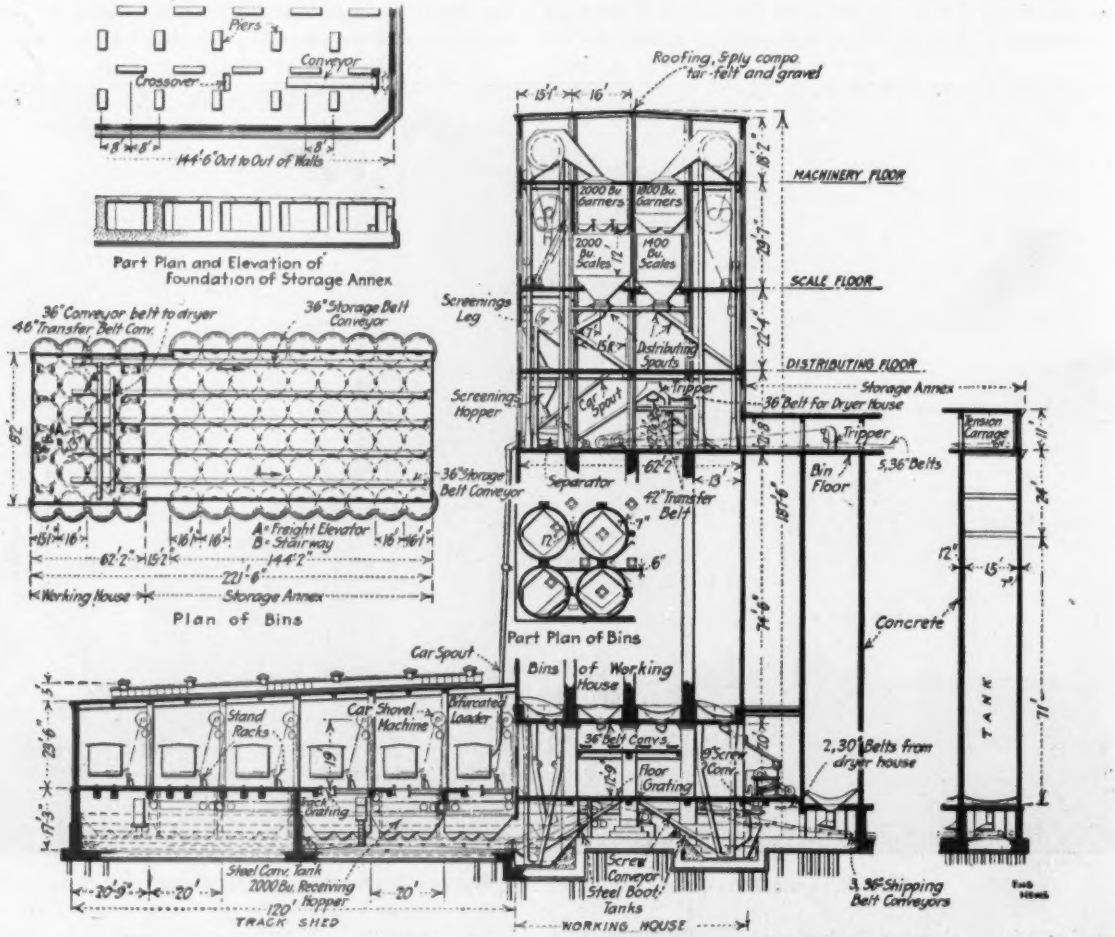


Fig. 3. Cross-Section and Details of the Girard Point Grain Elevator

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The amount of cement used was 1½ bbl. of cement for each finished cubic yard of foundation concrete, and 1¾ bbl. per yard for the superstructure and cupola. Enough sand was used to fill the voids in the gravel, plus 5%. The concrete was mixed to a fluid consistency and spaded in place to avoid the formation of pockets. The aggregate being taken in by barge was subject to irregular delivery due to stormy weather, thus making it necessary to use stock piles.

Two hoist towers were erected for hoisting the mixed

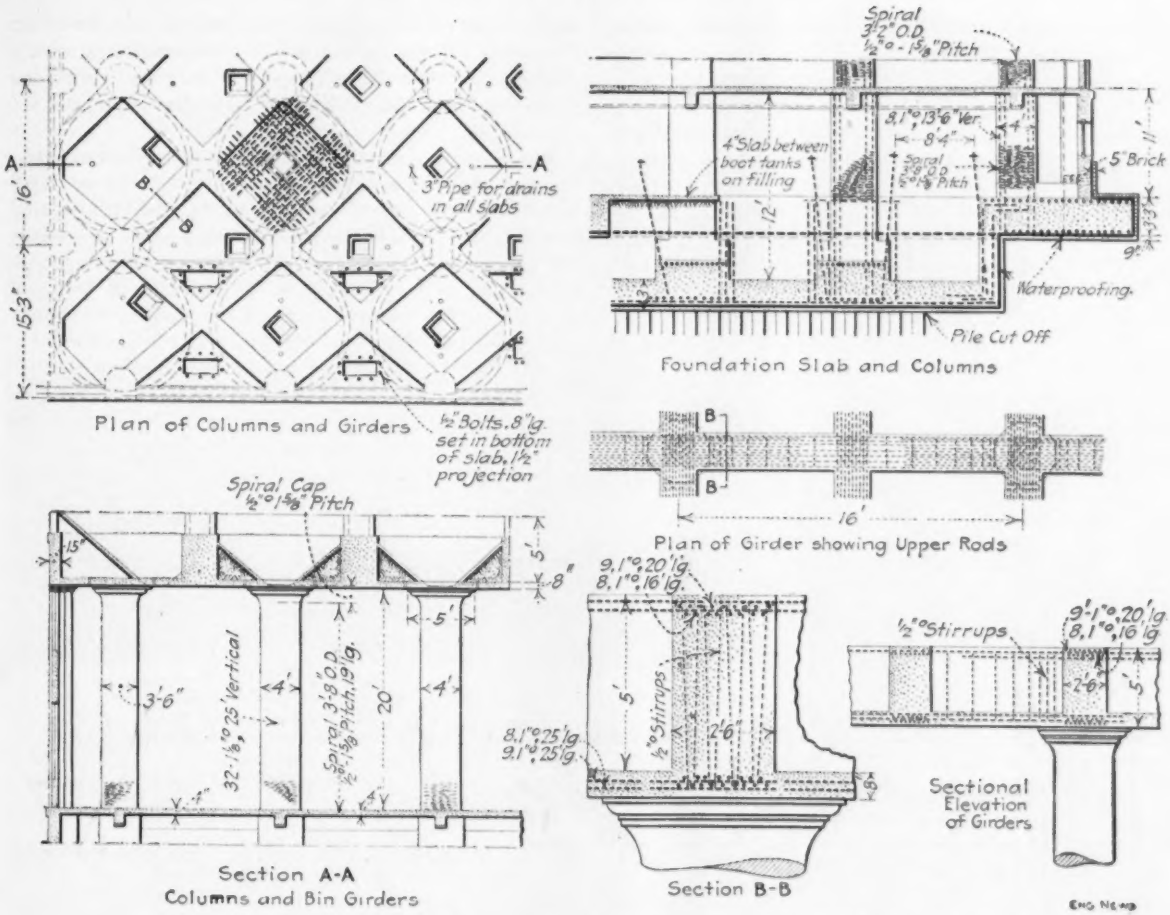
Plan of Columns and Girders
½" Bolts, 8" lg. set in bottom of slab, 1½" projection
3" Pipe for drains in all slabs
Foundation Slab and Columns
Spiral 3'-7" O.D. ½"ø - 1⅝" Pitch
4" Slab between boot tanks on filling
5" Brick
Waterproofing
Pile Cut Off
Plan of Girder showing Upper Rods
Section A-A Columns and Bin Girders
Spiral Cap ½"ø 1⅝" Pitch
32-⅞"ø, 25' Vertical
Spiral 3'-8" O.D. ⅝"ø Pitch, 19' lg.
8,1"ø, 25' lg
9,1"ø, 25' lg
Section B-B
9,1"ø, 20' lg
8,1"ø, 16' lg
½"ø Stirrups
Sectional Elevation of Girders

FIG. 4. DETAILS OF THE WORKING HOUSE OF THE GIRARD POINT GRAIN ELEVATOR

concrete, one serving the storage tanks and the other serving the working house, track shed and dryer house. A 1-yd. storage hopper receives the concrete from the hoisting bucket and serves the push carts used for depositing it in the forms.

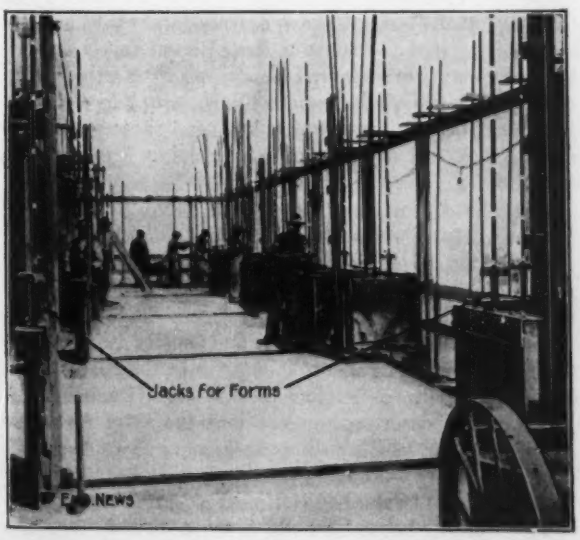

FIG. 5. REINFORCING AND JACKING RODS OF THE ELEVATOR BINS, WITH SCREW JACKS FOR RAISING THE FORMS

The job was organized and material received in October, 1912. The pile-driving contract was finished by February, 1913, and all concrete was laid from April to October following. The greatest number of men employed at one time was 350, with an average of 250 during the concreting season. The progress and the results in quality and finish of concrete attained with both moving and stationary forms were exceptionally good. As much as 10 ft. of vertical rise per day was made with the moving forms.

OPERATION OF THE ELEVATOR

RECEIVING—Grain is received from cars on six tracks in the track shed (Figs. 1 and 3), and each track crosses two receiving pits. The cars are hauled to and from the pits by cables operated from a six-drum car-haul machine in the north pit. At each pit is a power shovel (supported from the track-shed columns) which can unload at the rate of a car in 15 min. This is a plow hauled by a cable and drum and handled by a man in the car. The whole operation of spotting the car and unloading requires an average of 30 min. The gain drops into a 2000-bu. receiving hopper from whence it is spouted on the receiving belts. The slides under these hoppers are operated by an interlocking lever mechanism so designed

as to allow only one hopper to discharge on the belt at any one time. The receiving hoppers rest on ledges formed in the concrete walls of the track pits.

There are four 36-in. receiving belts (one for each battery of receiving pits), each having a rated capacity of 15,000 bu. per hr. and each discharging into a receiving leg of equal elevating capacity. The receiving belts and the lower portion or boot of the elevating legs are inclosed by the waterproof steel boot tanks, noted above. Both the receiving legs and the shipping legs can be used for shipping. The receiving and shipping legs have rope drives connected to 125-hp. motors. The 32-in. elevator belt has two rows of 15x8-in. buckets placed 13-in. c. to c. vertically.

The grain is discharged into the receiving garners (Fig. 3), each of 2000-bu. capacity. These have concrete sides and steel hopper bottoms with nine discharge openings which afford means for quickly and evenly filling the scale hoppers. The latter are also of 2000-bu. capacity, supported on the scale levers, and each discharges through a rotary valve into movable spouts. Each spout has two rotary joints which enable it to be doubled back upon itself, so that each spout commands an annular area on the distributing floor whose radii are the lengths of the spout when extended and doubled back.

There are 102 spout holes in this floor, from which spouts lead as follows: (1) to the working house bins; (2) to the five 36-in. belt conveyors discharging into the storage bins; (3) to the 42-in. reversible transfer conveyor on the gallery between the bin floor and the distributing floor, the tripper spout on this conveyor discharging the grain into spouts leading either to the working-house bins or upon the conveyors running to the storage bins; (4) to the car spout which leads down the side of the house into the track shed and can be used for loading cars standing on the first track; (5) to the 36-in. dryer belt (on the gallery beside the transfer conveyor), discharging into a swinging spout or turnhead which can deliver to any one of the four spouts leading to the dryer house.

This system of spouting makes it possible to reach any bin in either the working house, storage annex or dryer house from any one of the nine scales, besides affording facilities for direct loading into railway cars. To reduce the number of spouts, most of them are made compound, having one or two openings in the distributing floor and another for the tripper spout (of the transfer conveyor) at the gallery floor. The belts over the storage tanks are so placed that one conveyor can serve two rows of circular bins or the row of interstice bins directly under the conveyor. Fig. 8 is a view of this floor with the conveyors and trippers and the spout holes.

SHIPPING—The 12-in. circular bins and 15 interstice

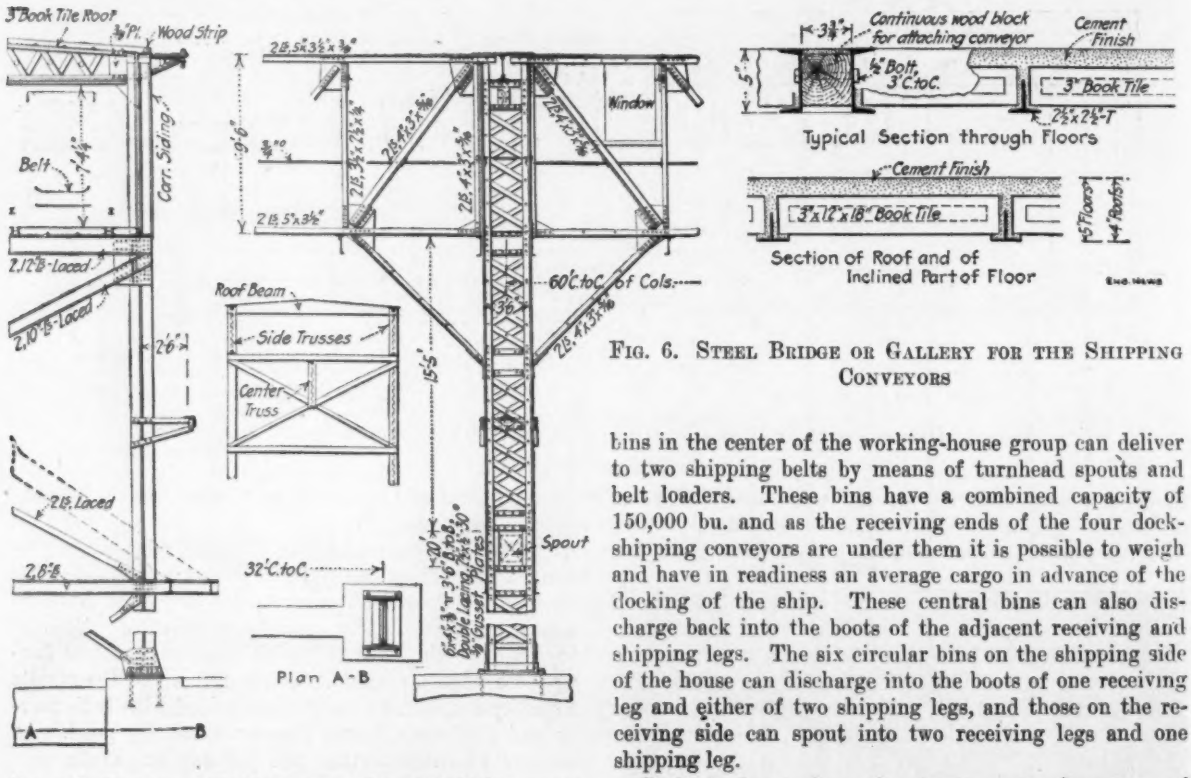

FIG. 6. STEEL BRIDGE OR GALLERY FOR THE SHIPPING CONVEYORS

bins in the center of the working-house group can deliver to two shipping belts by means of turnhead spouts and belt loaders. These bins have a combined capacity of 150,000 bu. and as the receiving ends of the four dock-shipping conveyors are under them it is possible to weigh and have in readiness an average cargo in advance of the docking of the ship. These central bins can also discharge back into the boots of the adjacent receiving and shipping legs. The six circular bins on the shipping side of the house can discharge into the boots of one receiving leg and either of two shipping legs, and those on the receiving side can spout into two receiving legs and one shipping leg.

Grain is drawn from the storage annex by means of the three 36-in. belt conveyors in the basement, each discharging into one shipping leg. These are similar in design and capacity to the receiving legs. The belts and draw-off spouts are located so that each belt receives grain from two rows of circular bins and one or two rows of interstice bins. The spouting of grain in the cupola from the shipping legs is similar to that from the receiving legs (already described) except that the shipping scales are of 1400 bu. and the shipping garners of 1800-bu. capacity.

The grain to be shipped is discharged into either one of the 27 working-house bins which spout directly onto the four 36-in. shipping belts running on the inclined portion of the bridge to the first tower. Here they rise and discharge onto the four 36-in. conveyors extending the full length of the level portion of the bridge (660 ft.)

and serving the dock spouts. The first six of these spouts deliver to the east side only, there being a berth on this side only, as shown in Fig. 1. The others deliver on both sides, as ships can lie on both sides of the outer portion of the dock. In either case, the dock spouts can be supplied from any one of the four conveyor belts by means of the compound spouts under the trippers.

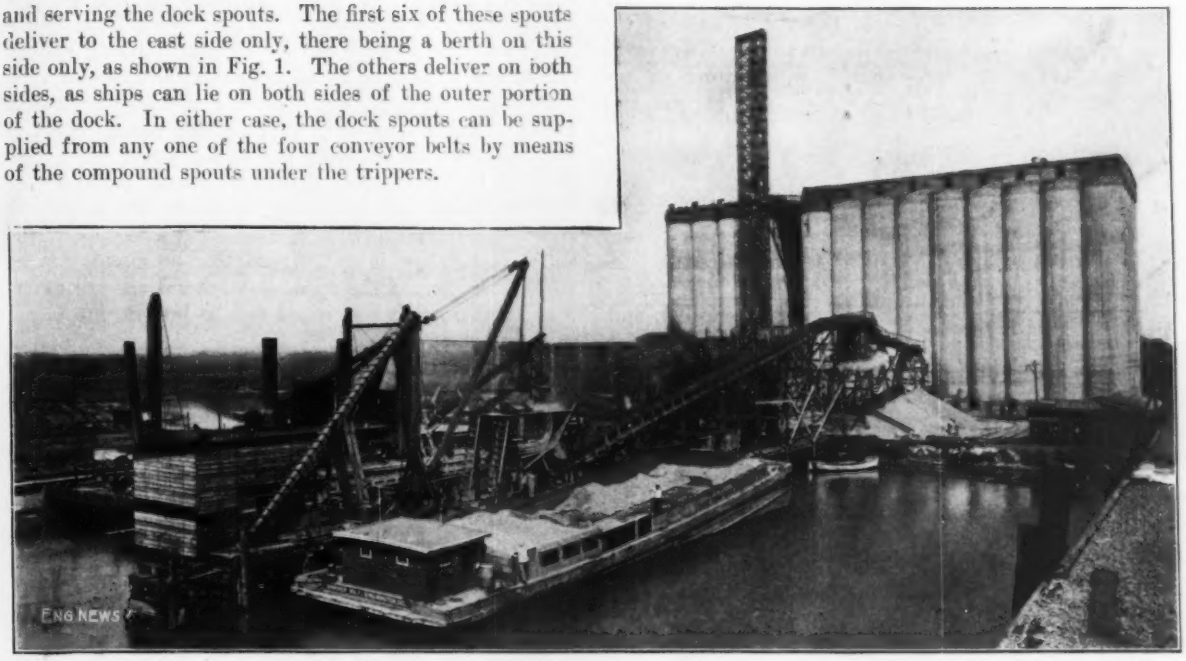

FIG. 7. SUPPLY AND CONSTRUCTION PLANT FOR THE GIRARD POINT ELEVATOR

The clam-shell derrick unloads concrete material from the barges to a hopper feeding an inclined conveyor, which delivers the material to stock piles. The concrete is raised in the tower and dumped into wheeled buckets for distribution to the forms.

These dock spouts are 66 ft. 7 in. above the dock (or 71 ft. 9 in. above mean high water) and have an extreme horizontal reach of 60 ft. when inclined 9 on 12; as shown in Fig. 9. This enables them to load the largest boats and to load into the farther of two ordinary vessels placed side by side. The channel and slips have been dredged to a depth of 35 ft. below low water.

CLEANING AND DRYING—The space between the working house and storage house is utilized for cleaning grain and handling grain from the dryer. There are four separators, each pair with a capacity of 10,000 bu. per hr., discharging the clean grain into two elevator legs. The screenings are delivered by screw conveyors to a leg which elevates them to a hopper on the distributing floor, from which they are fed to a second separator on the bin floor. This latter will handle 4 to 6 tons per hour. The valuable portion of the screenings is discharged into the working-house bins, while the coarse matter and dust are delivered to one of these bins which is used as the dust bin of the dust-collecting system.

The cleaner legs are utilized also for elevating the grain from the dryer, the belts from which discharge into these legs. The grain to be dried is spouted from any one of the receiving or shipping scales onto the 36-in. dryer conveyor on the gallery above the bin floor at the end of which is the turnhead for discharging into the spouts leading to the dryer house, as described above. The house has four units, each of 750-bu. capacity. From the garners the grain is charged into the dryers, the air for which is driven through the steam coils of two heaters located in the center panels on the same floor by two motor-driven fans located below them on the cooler floor. After drying, the grain is passed through the coolers and into the discharge hoppers located under them, from whence it is spouted onto either one of the dryer belts by means of compound belt-loading spouts.

The dust-collecting system is operated by two fans. A fan on the machinery floor collects the dust from the floor-sweeps in the cupola, the garners over the scales and the cyclone chamber over the screening separator, and discharges it into a cyclone located over the screenings bin. The other fan is on the first floor, taking the dust from the basement and first-floor sweeps and the four cyclones connected with the cleaning machines, and discharging it into the cyclone located over the screenings bin. There are 4 floor sweeps in the basement of the working house, 8 in the track-shed, 12 in the storage annex, 2 on the first floor and each of the cupola floors of

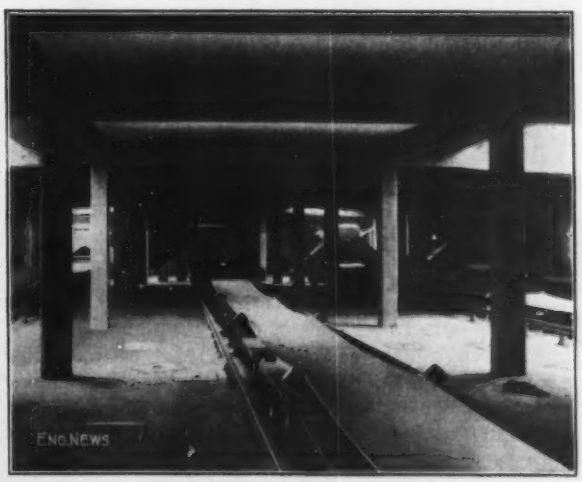

FIG. 8. INTERIOR OF CONVEYOR FLOOR ABOVE THE BINS OF THE STORAGE ANNEX

There are five 36-in. conveyor belts, each with a traveling tripper to deliver the grain from the belt to the various spout holes in the floor.

the working house, and one at the end of each of the five storage conveyors over the storage annex. The system is capable of taking dust simultaneously from all the dust collectors for the cleaning machines, garners and eight floor sweeps.

MISCELLANEOUS EQUIPMENT—The working house has a 1200-lb. freight elevator, extending from the first floor to the machinery floor, and there is also a spiral stairway, both occupying one of the bins. An elevator for tickets extends to the scale floor. An inter-communicating telephone system connects all parts of the plant, each instrument being arranged so that it may call any other, and two instruments are so equipped that they can ring all telephones simultaneously to call the superintendent or foreman at any part of the plant. Speaking tubes extend between the bin floor and scale floor, and communi-

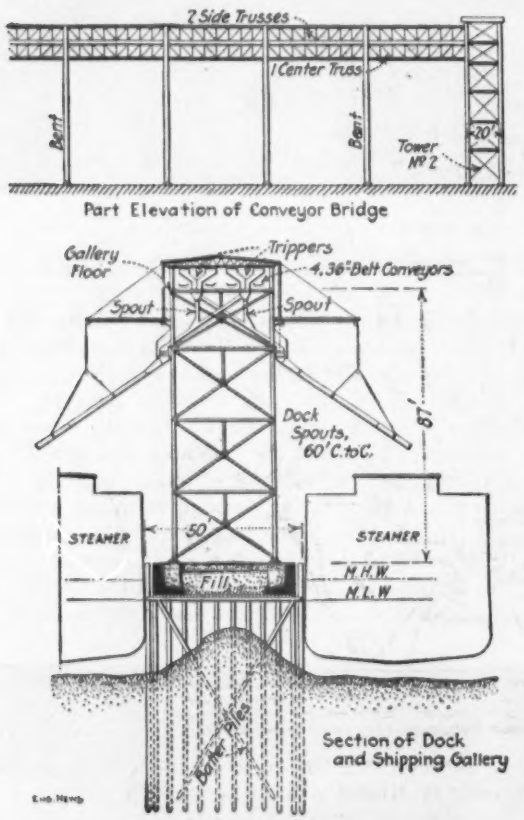

FIG. 9. CROSS-SECTION OF SHIPPING GALLERY AND PIER OF THE GIRARD POINT GRAIN ELEVATOR, PHILADELPHIA, PENN.

cation between the shipping, conveying gallery and the scale floor is had by means of electrical signal bells. A double-lamp signal (red and green) for each elevator leg is located on the first and scale floors, and a similar triple-lamp signal system affords communication between the men unloading grain from the tracks and those operating the elevators on the first floor.

POWER EQUIPMENT

Current is received from the Philadelphia Electric Co., through three high-tension leads coming into the tower of the transformer house built in connection with the dryer house. The voltage is stepped down from 13,200 to 440 for the motors and 220 for the lighting system. There are 30 motors (2105 hp.) of the induction type, three-phase, 60-cycle, and wound to operate at constant speed. They are provided with starting compensators of such capacity as to start the motor under light load without requiring more than 50% excess current. As dust explosions are frequently caused by the passing of an electric spark through a dust-laden atmosphere, the entire installation is so designed that no circuit can be made or broken in the open, and precautions are otherwise taken so that no circuit can be broken due to accumulations of dust.

In general, the machinery for a grain elevator consists of relatively few but massive parts, but these must be proportioned to withstand heavy wear. The item of machinery whose adaptation has more than anything else made possible the modern grain elevator, is the conveyor belt. The belts for the receiving, shipping and cleaner legs are made of 6-ply 32-oz. duck, having the several plies cemented together with rubber compound. The outside is covered with a $\frac{1}{32}$-in. coat of rubber, vulcanized and finished. The conveyor belts are similarly made in 4-ply. The stretch in the belts is provided for in the case of the elevator belts by giving the bottom or boot pulley vertical travel in a slotted bearing frame; and in the horizontal conveyors the end or tail pulley is mounted on an adjustable frame giving it a 3-ft. travel. The head or driving pulley is connected to the motor through a countershaft to reduce the speed.

Rope drives are used almost exclusively, the manila transmission rope varying from $\frac{7}{8}$ in. to $1\frac{1}{4}$ in. Tension carriages are chiefly of the vertical finger-guide type with tension weight varying with the rope from 200 to 300 lb. and a travel of $1\frac{1}{2}$ to 2% of the total length of rope in the circuit. Bearings in the form of pillow blocks are of the spherical ball-and-socket type, ring oiling and dustproof, whereas floor stands are made rigid. An automatic journal alarm system has connections to all bearings except the conveyor roller bearings.

ENGINEERS AND CONTRACTORS

The elevator was designed and built by the grain elevator department of James Stewart & Co., of Chicago, of which department R. H. Folwell is Chief Engineer, and W. R. Sinks is General Manager. J. S. Johnson had charge of the construction work for the contractors. W. H. Cookman is architect for the Girard Point Storage Co., and its engineer is A. C. Shand, Chief Engineer of the Pennsylvania R.R.

Electric Lights for Use in Gas Charged Rooms should be low candlepower carbon lamps, according to tests made by the Bureau of Mines. These tests showed that when incandescent lamps of high candlepower were broken in an atmosphere charged with inflammable gas, the gas was ignited in a large proportion of the cases. Tungsten lamps ignited the gas in 25 to 85% of the tests. The 8 candlepower, 220-volt carbon incandescent lamp, however, caused only one ignition in twenty tests, and this was a test made by breaking the tip from the bulb and allowing the gaseous mixture to enter in a small stream which did not break the filament. For additional safety it is recommended that wiring for electric light where gas is present should be installed in iron pipe conduits. If switches are used where gas is liable to be present the switch boxes should be made gas-tight. As an additional safeguard the incandescent bulbs may have heavy glass outer globes and metallic shields outside.

A Land-Drainage Problem in Missouri

By Charles H. Miller*

The St. John Levee & Drainage District, in the southeast section of Missouri, embraces the greater part of New Madrid and Mississippi counties, with a total area of 315,000 acres. It must provide for the drainage of an area of 425,000 acres (all of which should be included eventually in the district), bounded on the north by the Commerce Hills, on the west by the Sikeston ridge, and on the east and south by the Mississippi River. Part of this (40,000 acres) is now included in two smaller districts having outlets direct to the Mississippi River.

The first dredges were operated about 25 years ago, when land could be bought at $1.25 to $4 per acre. Since then, 15 drainage districts and 4 levee districts have been organized under the county-court law, and several hundred miles of ditches and 50 miles of levees have been built. The prices of these lands now range from $15 to $125 per acre. A map of the district, with the present and proposed works, is shown in Fig. 1.

Although it is probable that the St. John district eventually will take over and handle all the drainage and levee work, this cannot be done yet because of the many legal and political complications. The present aim of its managers and engineers therefore is to hurry the completion of the levee system; agreements have been made with the several levee districts as to where the work should be done, and each district will handle its part of the work to conform to the general scheme.

There will be much more difficulty in effecting an equitable consolidation of the several drainage districts. Some of these have purchased right-of-way and have constructed proper outlets, but many others have not done this. They all owe their existence to the county courts, and naturally one county will not be much concerned as to results outside of its boundaries. As some of these districts have been operating for many years, it is difficult to convince the landowners therein that they still owe something to the owners lower down, or that they should assist in the work of providing a different outlet for the surface waters.

A large part of the problem at this time is to control this drainage work and the levee work (without actually taking it over); continuing it so as to bring about one economical and complete scheme for the whole territory, and getting the different boards and interests to patch up their old differences and to work together in enlarging and extending the improvements. The scheme at this time is to provide only the levee work and the main trunk drainage.

In the reclamation of the overflow lands of the Mississippi Valley the real difficulties are more largely legal than engineering, and are brought about by the many political subdivisions that usually exist in one drainage district, we having as yet failed to reach that stage of progress where in the consideration of large public improvements we can wholly eliminate petty political jealousies.

Existing Conditions

Practically all the runoff from the entire territory passes into the Mississippi River through three channels (two natural and one artificial): James Bayou, St. John Bayou, and Lee-Rowe ditch. Connecting this ditch directly with the river was an ill advised proceeding, as an efficient outlet could have been secured at much less expense through James Bayou, and we would not be confronted at this time with the necessity of closing the mouth of this ditch. There is much sandy soil in this district, except in the lower portion.

In this territory there has been expended over $2,000,000 in reclamation work, and many drainage ditches have been constructed (mostly in the upper portions of the district). In addition, there is a line of levee (approximately 55 miles) along the Mississippi River extending to the south end of Mississippi County. This must be enlarged in order to afford reasonable protection to the land, practically every acre of which lies below the grade

Fig. 1. Map of the St. John Levee and Drainage District in Missouri, Showing the Present and Proposed Works

line here, and of course much below the grade line further up the river; and hence is always subject to overflow from a break in the levee, especially if the flood is of long duration.

Because of breaks near the upper end of the levee, during the floods of 1912 and 1913, approximately 300,000 acres were overflowed. Had the levee remained intact its entire length, then only about 190,000 acres would have been overflowed, this embracing the area now subject to back-water overflow from the head that obtains at the lower end of the levee in Mississippi county. This head can be reduced about 6 ft. by constructing an interior ditch to carry to St. John Bayou the waters from James Bayou and Lee-Rowe ditch, thus permitting the closing of their present mouths so that the levee can be extended

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across them and on to the mouth of St. John Bayou. Then only about 140,000 acres will be subject to back-water overflow or are so situated as to be below the high-water level at New Madrid, thus requiring pumping for final reclamation.

Although practically every acre of this district is subject to overflow, fully 285,000 acres are so situated as to be above back-water overflow that would enter at the mouth of the St. John Bayou. Therefore, it is possible to drain these lands by gravity and without pumping by simply constructing a high-level collecting ditch and discharging the waters into the river between levees that are above high-water stages. The recent high waters have demonstrated the fact that the present levees are not high enough to be safe and new grade lines have been established.

Additional Work Necessary

The work that is necessary in order to protect and reclaim these lands may be divided into two general classes:

1. Enlargement of levees and construction of additional levees, with flood gates at St. John Bayou.

2. Drainage ditches and pumping plants to dispose of the surplus rain water falling upon these lands:

A. To collect the waters from all the lands above back-water overflow and conduct them through a high-level ditch to the Mississippi River.

B. To conduct to St. John Bayou, through a low-level diversion ditch, the balance of the waters that would flow out at James Bayou and at Lee-Rowe ditch, so as to permit of the closing of these outlets, and thus lower the head of the back water.

C. Collection ditches on the lands below overflow and a pumping plant to take care of the surplus rain water during periods of overflow in the Mississippi River, or when the flood gates must be closed.

With the undeveloped condition of the low lands, it was deemed inadvisable to attempt the construction of pumping plants, and detailed estimates were not made to cover this and the necessary collecting ditches. It is possible to carry this drainage through the Sikeston Ridge and into the Little River valley and thence to an outlet through St. Francis River, thus saving the permanent expense of the operation and maintenance of pumping plants. But the political difficulties in the way of such a solution at this time are simply insurmountable. However, without pumping plants, but with flood gates in the levee at the mouth of St. John Bayou (which could be operated to exclude the flood waters from the Mississippi) very large portions of these low lands, especially when the rainfall is light, would receive material benefit; and this would obtain for considerable portions even with heavy rainfall.

For all of the above work, except item (C), the estimated cost is approximately $3,750,000. There is prospect, however, that the U. S. Government will aid (as it has in the past) in the construction of the levees, so that the direct expense to the land will not be so great.

After a careful consideration of the general project by many of the large landowners it was deemed best not to attempt the construction of the high-level ditch at this time, but to go ahead with the low-level diversion ditch and the extension of the levee system (Fig. 1). This will give the greatest benefit for the least expenditure in the shortest time, and will permit the development of much additional land which later on would be in a better position to bear a portion of the larger burden.

The question then arose as to the possibility of a portion of the whole work being able to serve the purpose for the time being, without adding something to it that would be thrown away later. Regarding the levee work there could be no difference; but it was necessary to investigate carefully the situation on account of the low-level diversion ditch being required to take care of the additional surface water which it is planned to carry (eventually) through to the river in the high-level ditch. Near the head of the low-level ditch is located what has been termed the "Ten-Mile Pond basin"; this is composed of several ponds that are joined together and embraces an area of approximately 6800 acres, and can be utilized for temporary storage, without causing injury to any good land, while the ditch is operating to carry the water through to St. John Bayou.

Runoff and Hydraulic Conditions

Drainage districts designed in this territory for ¼-in. runoff have never had overflow troubles, and the capacity of the sandy soil to absorb rain water is very great. It was decided that it would be sufficient for areas of over 300 sq.mi. to figure for $\frac{3}{16}$-in. runoff in 24 hr., and ¼ in. for smaller areas; no very small areas having to be considered in the work thus far planned.

Considerable interest centered in the fact that much water flowed in several of the existing ditches during the very dry season of 1913, due to subsurface flow. The head of the system of ditches was investigated without finding any inflow, in fact at a point 10 miles below the head the flow was practically nothing. At different points this subsurface flow was found to be 0.68, 0.37 and 0.26 sec.-ft. per sq.mi. The sandy soil carries much subsurface flow, and the actual construction of ditches collects this flow and carries it to the low-level lands, where it must be taken care of by ditches or by pumping, depending upon the stage in the river.

The levee grade line is placed at about 3 ft. above the high-water marks established at the time of the recent extreme flood, except at the lower end. There an increment of approximately 1 ft. has been added to overcome an assumed increased flood height on account of the leveeing of the basin above, as well as on account of a special levee likely to be constructed on Kentucky Point, just across the river from New Madrid, which will prevent flood waters from flowing across a narrow neck at that place.

For the ditch design, Kutter's formula with the factor $n = 0.025$ (except for special cases) has been used; and combining the assumed rate of runoff with the fall as found on the ground, the proper-sized ditch is obtained by the "cut and try" method. As the proposed main ditches do not follow the general direction of the slope of the country (averaging about 1 ft. per mile) they have to be designed with much flatter slopes, particularly the high-level ditch. The elevation of the grade of the bottom is fixed at the upper end by local conditions of drainage; then where it intercepts inflowing ditches at a grade which is more than a few feet below their present bottom-grade line, concrete spillways or drops must be provided.

The required height of the levees along the high-level ditch at points some distance from the mouth is a matter of considerable speculation, there being no way that we could find whereby, with the many variable conditions, it

was possible to figure out anything that would be better than a guess. Hence, they were placed at about 4 ft. above the assumed back-water.

In the location of this high-level ditch the same question of back-water height had to be considered in figuring what portions of the territory could be expected to drain by gravity during extreme floods in the Mississippi River. The best that could be done was to work from the actual conditions that took place during the recent flood as to back-water slopes, which slopes, on account of the breaks in the present levee at the time, were necessarily much disturbed.

City Front Levee at New Madrid

Although the city has been overflowed previous to 1912, the flood has never been more than 1 to 3 ft. deep, and has caused very little damage. The overflows of 1912 and 1913 were high enough to flood the city to depths of 5 to 7 ft. and demonstrated the fact that levee protection is absolutely necessary.

Some 15 years ago, the river bank along this entire front was protected with brush and riprap revetment which has prevented further erosion since that time. However, from the experience with similar work at other places, there is no positive assurance that breaks might not occur, and therefore it was deemed entirely inadvisable to try to protect this front with a concrete flood wall and the question of an earth levee was taken up.

At first, it appeared that there was no escape from property and right-of-way damages that would be equal to or greater than the cost of the levee embankment itself. Then consideration was given to the proposition of acquiring through the second block from the river only right-of-way enough for the levee and borrowing material from some point outside the city. Thus the front street, with the residences on either side, would be left without levee protection. To place such a levee in the front blocks would be unsafe.

Finally, it was decided to plan for the use of the front row of blocks, and with a suction dredge, pump in from the river sufficient material to construct a levee having a base about 200 ft. wide with 10-ft. crown and slopes about 1 on 10, first having raised all serviceable buildings so that they will be above the new levee, calculating to get a price per yard that will be enough lower to make up for the greater yardage.

Inverted Siphons

In order that the surface water from that part of St. John Bayou bottom which will be above the proposed high-level ditch or floodway, may be permitted to reach the mouth of the bayou, a large inverted siphon must be placed underneath the floodway. Other siphons must be placed under this floodway to provide gravity drainage for the lands on the east side of the Sikeston Ridge. As more or less silt will be carried during periods of flood, provision must be made for easily cleaning these siphons.

Ditch and Levee Construction Equipment

For the work heretofore built, as well as for that which is now under way in this section of the country, the floating-dipper dredge is used almost universally for the ditching, and teams with scrapers are used for the levees. In levee work the restrictions as to width of berm and depth of borrow pit make machine work more expensive than team work as a rule, but the time is rapidly approaching when some form of drag-line excavator will be in use more generally.

For the different classes of work now contemplated (Fig. 2), and considering all of the special conditions obtaining, we would expect to use the following equipment: (A) low-level ditch; a floating dipper dredge, of about 3½ cu.yd. capacity, or drag-line excavator. (B) High-level ditch; some form of large-sized drag-line excavator, preferably one on each berm. (C) Standard levee; teams and scrapers, drag-line excavator, or steam-shovel and dump cars. (D) Special levee; a floating suction dredge with about a 12-in. pump.

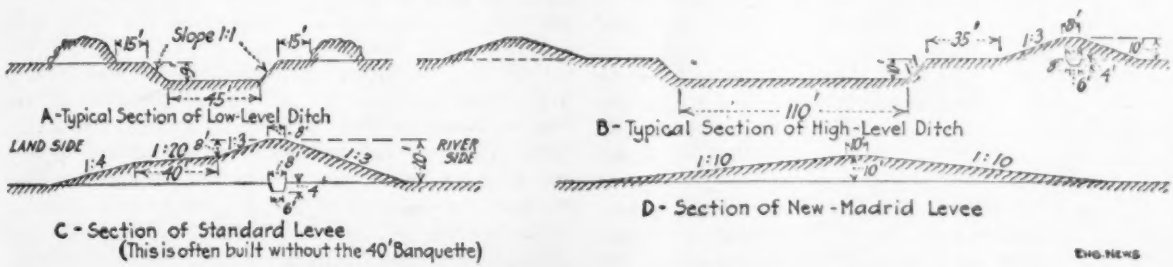

Fig. 2. Proposed Ditch and Levee Cross-Sections

In most of the ditches constructed in this territory considerable trouble has been experienced on account of the banks sliding, due no doubt in a large measure to the sandy subsoil. One of the best ways of overcoming this trouble is to construct the ditches with flat slopes. The floating-dipper dredge does not prove a satisfactory machine for making such slopes, and allowance is made for this by digging to a greater width of base; calculating that the ditch will still be of sufficient size after the sliding has ceased. Most of this sliding usually takes place within a short time after the ditch is first unwatered, and these slides follow no law, hence the result is not only a very unsightly piece of work, but often an inefficient one.

Although the design calls for slopes of 1 on 1, the writer is convinced that as a rule for this territory when the depth of ditch is more than 6 ft. it would be better not to have the slopes steeper than 1½ to 1 and that it will prove economical in the end to pay the increased first cost for such construction.

In scarcely any other class of work is there as much variation in unit price as in earthwork and to give figures without going fully into general details as to conditions, etc., is largely a matter of speculation. In general for this work we estimate that the prices will fall within the following limits (contractor's profit included):

dredge work, 7½ to 9c. per cu.yd.; drag-line work, 10 to 15c.; suction dredge, 12 to 18c.; team work, 16 to 25c.; steam-shovel work, 25 to 40c. On the suction-dredge work, the equipment cost will be large per unit because the amount of work is small.

Before the entire scheme is completed, the quantities will approximate the following: floating-dredge work (low-level ditch), 970,000 cu.yd.; drag-line work (high-level ditch), 10,200,000 cu.yd.; suction-dredge work, 200,000 yd.; levee work (all classes), 6,500,000 cu.yd.

Maintenance Experience with a Bituminous-Top Concrete Automobile Highway

In 1908, a private corporation was formed to build and maintain a motor speedway from the outskirts of the Borough of Brooklyn, New York City, through the center of Long Island. The purpose of the road, according to an address by W. K. Vanderbilt, Jr., one of the pro-

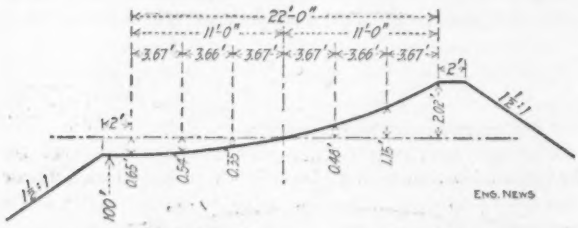

FIG. 1. CROSS-SECTION OF AUTOMOBILE HIGHWAY ON A 14° CURVE

moters, was "to have a highway free from all grade crossings, dust and police surveillance."

A right-of-way 100 to 200 ft. wide and 45 miles long was purchased; and every season since 1908, and including that year, a section of pavement has been laid; the last in 1913. It was originally intended to have a pavement 22 ft. wide, but after the first section was completed the subsequent sections were made only 16 ft. in width.

This road, known as the Long Island Motor Parkway, furnishes an excellent study in road maintenance under special conditions. It is operated as a toll road. Nothing but pleasure motor vehicles and motorcycles are allowed; their number is, of course, known exactly; the maintenance is all supervised by a single individual; so that the road as a whole is an interesting experiment with the particular types of construction adopted. The problem, as is readily seen, is resolved into maintenance against weather and natural conditions, rather than against traffic; so that the opportunity to study this element by itself is unique.

CONSTRUCTION

FOUNDATION—The road is built for the most part through a naturally well drained sandy loam, such as covers the greater part of Long Island. Much of the road is comparatively level, the natural surface having gentle slopes, although some of the overhead highway and railway crossings have grades as steep as 8%. In occasional instances, where the natural drainage was poor, tile underdrains were inserted. The earth subgrade was rolled and surfaced to the crown of the finished pavement.

PAVEMENT—Methods of construction varied slightly from year to year. The section of 8½ miles built in the summer of 1908 was a 5-in. reinforced-concrete pavement. No contraction joints were inserted at the time of construction.

Because the glare of the white surface was objectionable, a bituminous material was subsequently sprayed on and sanded, forming a very thin carpet. After the construction of this first section, no reinforcement was used, and a plain concrete base, with bituminous top coat, was constructed, as explained further on.

The reinforced-concrete pavement was constructed by spreading over the finished subgrade a thin layer of trap rock, 2 in. in greatest dimension. On this layer of crushed stone was spread a wire netting of American Steel & Wire Co., No. 12, 4-in. triangular mesh. Above the wire was spread another thin layer of stone, of 2-in. size; the whole depth of stone not exceeding 5 in. after rolling with a 10-ton steam roller.

The crushed-stone bed was filled with portland cement grout mixed 1:1:1, cement, sand and trap rock, pea size, was poured into the interstices, according to the patented Hassam process. The surface was rolled with a 10-ton roller until no water flushed to the top; the surface was then finished with hand tampers and brushed with rattan brooms. No smoothing or troweling was done, so the surface was left moderately rough and gritty. Shoulders were constructed of earth, compacted by rolling on a 3-ft. strip each side of the pavement. This pavement was guaranteed for five years.

The section built in 1909-'10 was 13½ miles long and

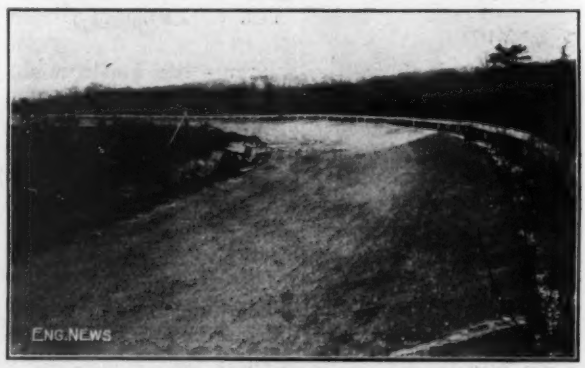

FIG. 2. A 14° CURVE DESIGNED FOR 40 MILES PER HOUR

was constructed of a 3-in. plain gravel-concrete base with a 1½-in. "Apposite" top, a patent bituminous preparation included under the general classification, bituminous macadam. The concrete was mixed in the proportion of 5 bags of cement to a cubic yard of gravel. The surface of the concrete was left rough, and stones 1½ to 1 in. in size were set in the soft concrete and left projecting. On this was placed the 1½-in. wearing coat of 2 parts sand and 1 part gravel mixed with bituminous binder, according to the specifications for the Hassam Co.'s "Apposite." The concrete surface was given a thin coat of bitumen before the wearing coat was spread. The wearing coat itself was spread and rolled like sheet asphalt with a 5-ton roller.

FIG. 3. MILE STRAIGHTWAY, PART OF VANDERBILT CUP RACE COURSE IN 1908

Subsequent sections built in 1911, '12 and '13 were constructed of a 4-in. gravel-concrete base with a ⅜- to ½-in. bituminous wearing coat of the type known as "Hassamite." The coating was sprayed on in two coats under about 300 lb. steam pressure. This pavement is guaranteed for 10 years.

CROSS-SECTIONS—The pavement cross-section has an average total crown of about 4 in. or only about ½ in. to 1 ft.; in some places the crown appears less. On curves, a superelevation and dished cross-section shown in Fig. 1 was used; this inverted curved section had the low point 2.67 ft. below the outside shoulder. The particular curve shown in Fig. 1 was one of 14°, or one of 410-ft. radius. It was designed for a speed of 40 miles per hour. Fig. 2 is from a photograph of the same curve.

TRAFFIC AND MAINTENANCE

TRAFFIC—The traffic, as already noted, is entirely pleasure motor vehicles with pneumatic tires. The largest day's record is 1500 cars, and an average day's traffic is 100 cars. The speed limit is 40 miles per hour, although on straight-way sections, cars ordinarily travel at a much higher speed. In 1908, '09, '10, the Vanderbilt Cup Race course included a part of the parkway, and the speeds approached 100 miles per hour.

MAINTENANCE—There has been but very little repair work necessary. This consisted merely in patching the bituminous top coat and in inserting expansion joints. At the beginning of the spring season a 3-man gang can in three weeks make all nthe necessary patches. The old surface is first swept clean and then a heated bituminous mixture of 2 parts bitumen and 1 part sand is applied, spread with a stub broom and covered with gravel. Rolling is not resorted to. The only other repairs necessary have been in about 60 instances on hot summer days when the pavement expanded sufficiently to bulge. Where this happens, the pavement is cut out and an expansion joint inserted.

FIG. 4. HOLES IN BITUMINOUS CARPET, 1908 REINFORCED-CONCRETE PAVEMENT

FIG. 5. TYPICAL TRANSVERSE CRACK

PRESENT CONDITION OF ROAD—The accompanying views were taken the first week in May of this year, before the regular spring patching, and just as the pavement appeared after the winter and during the spring season. Fig. 3 is a view of the one-mile straightaway stretch of road on the reinforced-concrete pavement put down in 1908. This is in excellent condition. The tranverse contraction joints and cracks are filled with material from the top coating and the surface is comparatively smooth and unbroken.

In several parts of this section of pavement, places were found like those shown in Fig. 2, where the thin bituminous-wearing coat had broken out. In almost every instance, the concrete surface beneath was very smooth. These holes in the top coat, it appears, are due to water and frost between the concrete base and the bituminous coat, and frequently occur season after season in the same place, owing to the difficulty of making a waterproof patch.

Fig. 5 shows a typical transverse crack, of which there were many. Fig. 6 shows a typical longitudinal crack, of which there were very few. Fig. 7 shows a form of incipient disintegration due to the failure or erosion of the earth shoulder; water apparently has found its way between the concrete and the sub-base; such instances, however, are rare.

Fig. 8 shows an experimental expansion joint installed during the last year; this is the only one of the kind in the road, the others being of a more simple construction, as described below. This joint consists of two ⅛-in. soft-metal plates with a strip of felt between. The concrete has practically broken away from the plates, and the felt works out of the joint, leaving a bad appearing and bad riding break in the road surface. In placing expansion joints at places where the pavement actually heaves in hot summer weather, the regular practice has been to cut away about a 12-in. transverse belt of pavement and insert a ½-in. strip of felt, on each side of which is placed a 6-in. width of tar macadam.

Expansion joints were not used on the original construction, as already noted, but were inserted thereafter by the contractor at such points as required. As the pavements were laid under long-term guarantees, the contractor was allowed to follow his own beliefs regarding the necessity of expansion joints with the proviso that any damage due to expansion would be repaired under the guarantee, and joints inserted where necessary before the expiration of the guarantee period.

The general appearance of the surface of the pavement is that of a tar sidewalk. The surface is rough and gritty and yields a black char which coats the tread of the rubber tires. Fig. 9 illustrates the character of this surface.

As a whole, the pavement has resisted weather conditions for various periods of from one to six years with very fair success; and with the moderate amount of repairing referred to (less than $150 a year for the entire road), and an occasional coat of tar and gravel, the pavement is apparently good for many years, under the traffic it now carries; but its value as an example of this type of construction is, of course, limited by conditions which seldom exist elsewhere. It serves chiefly as an example in differentiating between disintegration due to wear and tear and that due to weather.

The President of the Long Island Motor Parkway is W. K. Vanderbilt, Jr.; the Manager is A. J. Kienzle,

FIG. 6. TYPICAL LONGITUDINAL CRACK

FIG. 7. INCIPIENT FAILURE DUE TO LACK OF SHOULDERS

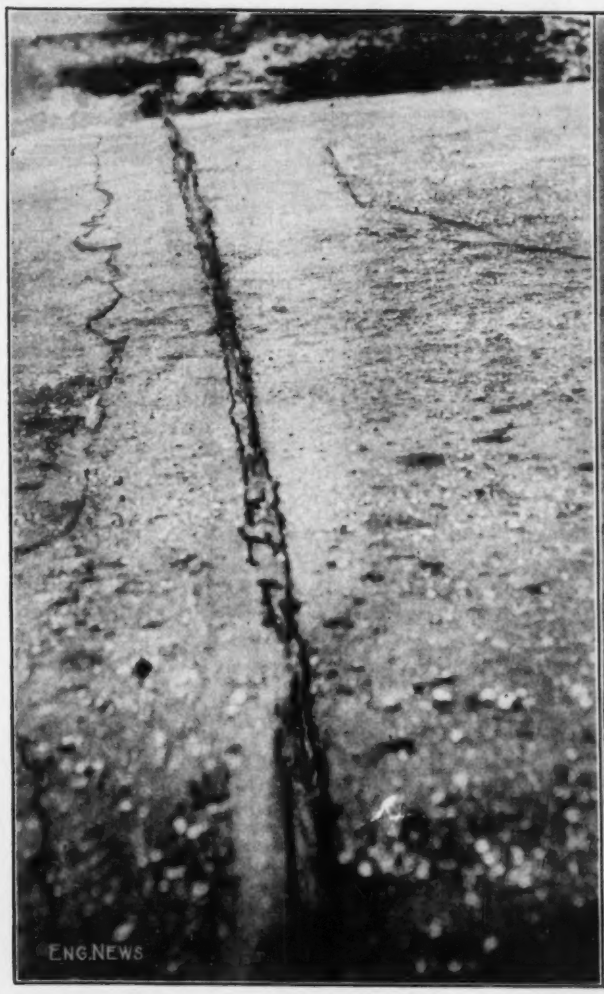

FIG. 8. OLD-STYLE EXPANSION JOINT, WITH METAL PLATES

FIG. 9. CHARACTER OF ROAD SURFACE

Mineola, N. Y.; the Chief Engineer of Construction was E. G. Williams, and the contractor the Hassam Paving Co., of Worcester, Mass.

The Railway Gage Problem in India

The railways of India aggregate about 18,260 miles of 5½-ft. gage (The Indian standard gage) and 14,750 miles of meter gage, besides some 3000 miles of narrower gages (24-in. and 30-in.). With various railway systems more or less isolated, the break of gage is a serious source of delay and inconvenience, and as there is strong possibility that the railways may have to serve a strategic purpose, the troubles due to break of gage are of military as well as commercial significance. In certain cases a third rail has been laid on standard-gage stretches of line to link together independent meter-gage systems, but this is merely a makeshift. This "battle of the gages" extends over an area of 1,800,000 sq. miles and effects a population of 260,000,000.

The problem of the unification of gage in India has been brought forward again recently by Sir Guilford Molesworth, consulting engineer, in a paper read at a meeting of the East India Association, in London. He pointed out that as far as cost of construction is concerned, there is very little difference. The saving in earthwork is small (not exceeding 3% even in embankments 50 ft. high. The cost of large bridges per mile forms a large proportion of the total cost of the railways, but this cost is affected but slightly by difference in gage. In the case of three large bridges aggregating nearly three miles in length a comparative estimate for the meter and 5½-ft. gages showed a difference of only 3%, the cost of abutments, piers, foundations and river training works being practically the same for both gages.

The narrow-gage movement affected India some 40 years ago, and the meter-gage was adopted for certain lines in 1873 on the sole ground of economy of construction. The actual saving, however, was slight, and at the present time there is practically no difference in cost. One of the principal items of saving on the early lines was in the light track and equipment, but instead of 35-lb. rails and 12½-ton locomotives the meter-gage lines now have 60-lb. rails and 40½-ton engines. Light railways of standard gage can be built as cheaply as those of narrow gage, and can carry ordinary equipment, with the

exception of the heavy main-line locomotives. The question of uniformity of gage is distinct from that of the comparative merits of broad and narrow gage, but Mr. Moleworth considers the 5⅛-ft. gage the better for transporting the bulky agriculture produce which forms the chief part of the railway traffic in India, besides being far better for the transport of artillery and war material.

As to the military aspect, as long ago as 1873 Lord Roberts made a strong protest against break of gage in the frontier railways, pointing out the inevitable confusion and delay due to the transfer and rehandling of material or troops instead of running military trains through to their destination. This protest led to the abandonment of projects for narrow-gage frontier lines, and to the widening of some 1000 miles of lines that had been built. However, with the present lack of uniformity throughout the country, it is impossible for the railway administration to deal properly with great congestions of traffic, as rolling stock cannot be transferred from one line to another to meet the contingencies which arise in India due to flood, famine, heavy crops, concentration of troops, and other causes.

It is considered that the proper remedy is to convert the meter-gage lines to the 5½-ft. gage, but the mileage to be changed is so extensive that the only practicable course is to adopt a fixed policy for the gradual conversion of the lines as their traffic outgrows their capacity or as opportunity may offer. On some meter-gage lines the limit of capacity has been reached, and the question has arisen whether these should be double-tracked or converted to 5½-ft. gage. It is considered that the latter would give ample increase in capacity, at much less cost, and with the advantage of reducing the difficulties of the gage problem.

The Use of Lime in Water Purification

By Charles P. Hoover* and Russell D. Scott†

SYNOPSIS—The use of lime in water purification is gaining ground. It is already being used at New Orleans, St. Louis, Cincinnati, Columbus, Oberlin, McKeesport, Fargo and many smaller places. Saginaw, Mich., expects to soften its water with lime, and Cleveland is even going to soften its lake water with lime. Numerous letters from sanitary, municipal and railroad engineers asking for information on lime treatment of water have led the authors to prepare a review of the subject in general and to give specific information regarding experience with the lime process at Columbus. Besides the information on Columbus here given, a later article will deal with lime-handling methods and apparatus in that city.

The advantages of adding lime to a hard magnesium water, such as is being treated at the Columbus water-softening and purification plant, are as follows:

(1) The water is softened.

(2) Intestinal and pathogenic bacteria are killed and thereby the water is rendered safe bacterially.

(3) The water is clarified.

(4) Color is removed.

(5) Lime-softened water is not corrosive to iron pipe, thus no trouble is experienced from the accumulations of "red water" in dead ends of the distribution system.

(6) The sterilizing action of lime persists indefinitely.

(7) Nothing is added to the water that was not there originally, as the lime combines with CO_2 present in the water to form ($CaCO_3$) calcium carbonate which is insoluble and is removed.

Softening Water with Lime

In order to remove the temporary hardness of water to the lowest possible figure, lime should be added in quantities just sufficient to absorb the free and half-bound carbon dioxide, and to precipitate the magnesium. If more lime is added than is necessary to absorb the carbon dioxide and to combine with the magnesium, then the water will be overtreated with lime and will have a caustic reaction.

Under ordinary operating conditions, in softening water with lime for municipal purposes, care should be exercised in order to reduce the temporary hardness to the lowest possible figure, and still not leave residual or excess lime in the softened water.*

If the alkalinity to phenolphthalein is more than one-half the total alkalinity, too much lime has been added and the water will contain caustic alkalinity; on the other hand, if the phenolphthalein alkalinity is less than one-half of the total alkalinity not enough lime has been added and the water contains bicarbonate alkalinity.

The ideally lime-softened water should contain neither caustic nor bicarbonate alkalinity.

The following table shows in parts per million the reaction between alkalinity by phenolphthalein and that by erythrosine or methyl orange in the presence of bicarbonates, normal carbonates and hydrates.

No.	Suppose the alkalinity to methyl orange or erythrosine to be	And the alkalinity to phenolphthalein to be	Then the analysis would show: Bicarbonates	Normal carbonates	Excess lime or causticity
1	44	0	44	0	0
2	44	20	4	40	0
3	44	22	0	44	0
4	44	24	0	40	4

Sample No. 1 contains no lime. No. 2 contains too little lime. No. 3 contains exactly the correct amount of lime. No. 4 contains too much lime.

During the past five years the average alkalinity of the Scioto River water at Columbus has been reduced from 153 parts per million to 48 parts per million, and

*Chemist-in-Charge and †Assistant Chemist, Columbus Water-Softening and Purification Works, Columbus, Ohio; Dublin Ave., Route 5.

*The following tests should be made in order to guard against over or under treatment:
(1) Determine total alkalinity by titrating 100 c.c. of the softened water with N/50 H_2SO_4, using methyl orange or erythrosine as an indicator.
(2) Determine alkalinity by titrating 100 c.c. of the water with N/50 H_2SO_4, using phenolphthalein as an indicator.

the average caustic alkalinity has averaged 1.5 parts per million.

History of Lime Sterilization

Lawrence Experiments—The first detailed study of lime treatment, known to the authors, was made by Allen Hazen at the Lawrence Experiment Station, in 1888. On adding lime to crude sewage he noted a progressive bacterial reduction with increasing quantities. Adding just enough lime to soften the sewage he found a bacterial reduction of 97.9%, and still higher percentage when excess lime was present.

Experiments at Cincinnati—Lime was added to water, with the idea of sterilizing it, at Cincinnati, in 1899 by the Ohio Sanitary Engineering Co., under the supervision of Geo. W. Fuller, who noted a high bacterial reduction in the treated water (94.5%) but attributed it specifically to coagulation rather than to sterilization.

Excess-Lime Method—Dr. A. C. Houston, Chemist of the Metropolitan Water Board, London, England, in the Eighth Research Report of the Metropolitan Water Board, proposed an excess-lime method of sterilizing water. His conclusions were founded on his observations, that quicklime added to raw Thames water in the proportion of 1 part of quicklime to 5000 parts of water, kills B. Coli in 5 to 24 hours and inferentially but certainly, the microbes also of epidemic water-borne diseases, for example the typhoid bacillus.

He proposes purposely to overdose a part of the water with lime, so as to bring about a known bacterial effect, and then after a suitable interval, to mix this portion with enough water, adequately stored or sterilized with ozone or hypochlorite, to neutralize the excess lime. He states in his report that the excess lime is responsible for germicidal action, and that if just enough lime is used to neutralize the bicarbonate alkalinity of the water, no bactericidal action is effected. It is noted in looking over the results of Dr. Houston's work that the excess lime was indicated by the red color produced when phenolphthalein was added to the treated water. The fallacy of this method of measuring excess lime has been stated in a previous paragraph and needs no further comment, but we suggest that this method of chemical technic may have led Dr. Houston to believe that he was using a large excess of lime, when in reality he was measuring the normal carbonates of calcium and magnesium, and not the excess lime.

Experiments at Columbus, Ohio—It has been observed that bacterial tests made for the presence of intestinal bacteria, in the softened water, collected from the outlet of the sedimentation basins at Columbus, Ohio, are negative 92% of the time in 1 c.c. portions. An investigation was made to learn just why the lime-softened water was so free from intestinal bacteria.

The results of bacterial tests made on lime-softened water containing no excess lime at the Columbus water-softening and purification plant, during the past four years, and also the results of numerous laboratory experiments lead us to believe that the action is not necessarily due to the toxic effect of excess lime, but that intestinal bacteria are killed when just enough lime is used to neutralize the free and half-bound carbon dioxide in the water. Bacteria belonging to the colon or typhoid group seem to require carbon dioxide for their develpment.

If two samples of water, one containing CO_2 and the other free from CO_2, be inoculated with typhoid or colon bacilli, these organisms will live in the carbonated water, but will die in water free from CO_2. This was demonstrated in the laboratory of the water-purification plant in several ways:

(1) Samples of well water free from intestinal bacteria but containing free CO_2 were divided into two portions. One portion was boiled until all the CO_2 was expelled and was then carefully cooled to prevent absorption of CO_2 from the atmosphere. The other portion was not boiled. Both portions were inoculated with typhoid and colon bacilli. These organisms lived in the water that had not been boiled, or in any other words, the water that still contained CO_2, but they died out completely in 48 hours time in water that was free from CO_2.

Even supplying the boiled water with oxygen did not render it suitable for sustaining bacterial life.

The results of these experiments tend also to support the contention that excess lime is not the essential factor in producing a water unfavorable to the growth of intestinal bacteria, because in this case lime was not used to absorb the CO_2.

(2) Samples of the softened water collected from the outlet of the sedimentation basins, containing no free and half-bound CO_2, were inoculated with from 5000 to 10,000 intestinal bacteria per c.c. After 24 hours, these samples became free from these organisms. On the other hand these organisms inoculated into the softened water after it had been carbonated with CO_2 lived and sometimes even increased in numbers.

Over 1000 bacterial tests were made on samples of river water, first inoculated with enough crude sewage to introduce from 3000 to 8000 colon bacilli, and from 40,000 to 50,000 total numbers of bacteria, per c.c. These samples, after being inoculated with sewage, were softened with lime. Bacterial analyses were made after 5- and 24-hour intervals. In order to find out whether or not the bacteria were simply dragged down mechanically by the precipitate, or were actually killed, samples of clear supernatant solution were tested, then the samples were vigorously shaken and a second set of tests made.

The results of these tests indicate that lime has a selective action. Intestinal bacteria are destroyed but the reduction of total number of bacteria is not high. Intestinal bacteria are killed and not simply removed by the precipitated carbonates, because the number of intestinal bacteria was no higher in the samples that were shaken than they were in the samples of supernatant liquor. Twenty-four hours contact is not sufficient to insure sterilization of intestinal bacteria, unless the water is overtreated with lime.

Treatment of Sewage Effluents with Lime

Effluents from the sewage-disposal plant at the Ohio Girls Industrial School were treated with lime. The sewage plant at the Girls Industrial School comprises septic tank treatment, sprinkling filters and slow sand filtration.

The raw effluent from the Girl's Industrial School showed the following bacterial analysis:

Quantity of sewage tested, c.c.	Gas production in lactose bile. Period of contact, hr. 5	24	48	72
10	+	+	+	+
1	+	+	+	+
1/10	+	+	+	+
1/50	+	+	+	0

+ = positive reaction, 0 = negative reaction.

Samples were treated with 8.5, 9.3 and 11 grains of lime. The latter proved to be just enough to neutralize the temporary hardness and leave no excessive lime.

The following table shows the bacterial results obtained after the lime treatment:

Period of contact	5 hr.			24 hr.			48 hr.			72 hr.		
Grains per gal. of lime added	8.5	9.3	11.0	8.5	9.3	11.0	8.5	9.3	11.0	8.5	9.3	11.0
Gas production in lactose, 10 c.c.	+	+	+	+	+	+	+	+	0	0	0	0
Bile solution, 1 c.c.	+	+	+	+	+	0	+	+	0	0	0	0
1/10 c.c.	+	+	+	0	0	0	0	0	0	0	0	0
1/50 c.c.	+	+	+	0	0	0	0	0	0	0	0	0

+ = Positive reaction. 0 = Negative reaction.

The results show that excess lime is not necessary, provided sufficient period of contact is allowed.

The results of additional experiments on sewage effluents show that the disinfecting action is not complete when large amounts of organic matter are present.

Conclusions as to Water Disinfection by Lime

Many other laboratory experiments were made and the results of these experiments, as well as results of analyses of samples collected at different points in the plant, seem to indicate the following conclusions:

(1) When enough lime is added to water to absorb the free and half-bound carbonic acid, and to precipitate the magnesium, the bacteria of the colon and typhoid group are killed in 48 hours after being so treated, provided the water does not contain large quantities of organic matter.

(2) The germicidal action is effective in from 5 to 24 hours when an excess of ½ to 1 grain per gal. is added beyond that needed to reduce the temporary hardness to the lowest possible figure.

(3) Intestinal organisms will not live in water containing no free and half-bound carbonic acid.

(4) Lime-softened water inoculated with typhoid organisms or with crude sewage soon becomes free from them.

(5) The action is selective in that certain harmless bacteria grow, but the disease-producing germs do not.

(6) Turbid water can be successfully disinfected by softening with lime and then allowing the turbidity to settle out, along with the precipitated carbonates. Turbid water has never been successfully disinfected with hypochlorite, because the bacteria imbedded in the suspended matter are not destroyed.

(7) The sterilizing action persists indefinitely. In a paper on water disinfection by chemical methods, Samuel Rideal states the advantages of using chemicals that persist in their disinfecting action, in the following words:

> It is at the same time a disadvantage, if a disinfectant however powerful in its first onset, is very evanescent, as many disease germs are strongly resistant, and we know that the time factor is of extreme importance in steilization.

Lime-Softened Water for Swimming Pools

Since lime-softened water is a poor medium for the development of typhoid and colon bacilli, it appeals to the writers that for use in swimming pools a filtered water previously treated with lime in quantities sufficient to neutralize the temporary hardness and to introduce 2 or 3 grains excess lime would prove to be a very satisfactory and safe water for bathing purposes.

The advantage of caustic water over water sterilized with hypochlorite is that the disinfecting action of the caustic persists, and if the water should become contaminated with pathogenic organisms they will soon become attenuated, and finally die, because there is no carbonic acid in the water, and carbonic acid seems to be essential for their development; whereas a water sterilized by hypochlorite might be satisfactory at the time of being pumped into the pool, but as soon as all the hypochlorite has become dissociated, the chemical offers no resistance to the development of disease-producing organisms that might be introduced into the water by the bathers.

Sterilization of Water Mains

During the floods at Columbus, in March, 1913, it was necessary to stop pumping for a period of 24 hours on account of a section of 36-in. pipe being washed out by the flood water. The distribution system was drained, and the local health authorities advised the people to boil the water, fearing that the mains would become contaminated with surface water. Knowing from our experiments that B. Coli, B. typhosus, B. paratyphosus, and intestinal bacteria will not live long in caustic water, the method of treatment, after pumping was resumed, was as follows:

The water at the plant was treated with enough lime to neutralize the temporary hardness of the water and, in addition, enough to introduce from 1 to 2 grains caustic alkalinity. Samples of the water were collected from all parts of the city, and 24 hours after, the water taken from all parts of the distribution system, showed, by the chemical tests, the presence of excess lime or caustic alkalinity, the water was found to be bacterially pure. This treatment is safe, it does not introduce any taste into the water, and there is no evidence, except by chemical tests, to indicate the presence of causticity in the water.

Better Coagulation Is Effected by Lime Treatment

Lime reacts with the magnesium compounds present in the raw water to form magnesium hydroxide, a bulky, gelatinous precipitate which coagulates the suspended clay particles or mud as readily as the precipitates formed by sulphates of alumina or iron. During the period of the year when the river water is extremely muddy, lime is added to water at the extrance of the mixing tanks in quantities sufficient to introduce excess lime, and better coagulation is affected than when just enough lime is added to neutralize the temporary hardness. This is due to two factors: (1) Magnesium hydrate ($Mg(OH)_2$) is precipitated in the presence of free lime ($Ca(OH)_2$); and (2), in the presence of hydroxyl ions, the negatively charged clay particles are repulsed and set in motion by the negative OH ions. They strike against each other and are held together by mutual attraction,[1] forming masses sufficiently large to settle readily. The causticity is neutralized by adding a small amount of alum to the settled water just before it goes to the filters.

The advantages resulting from this method of treatment are: Causticity kills intestinal bacteria, while

[1] "The action of Hydroxyl Ions on Kaolin Suspensions." P. Rohland. Z. Chem. Ind. Kolloide II, 193-5.

other bacteria and mud are dragged down mechanically, thus leaving less for the filters to remove; consequently, the filter runs are lengthened and less wash water is used.

The average turbidity of river water treated at the Columbus water-purifications works, for the years 1910, 1911 and 1912, was 63 parts per million. After being treated with lime, soda-ash and alum, the water was allowed to settle for about 12 or 15 hours, and the average turbidity of the settled water was less than 5 parts per million. From June 1, 1912, to Jan. 1, 1913, the turbidity averaged less than 1 part per million, the settled water being so clear that the filters were kept in service on several occasions for a period of seven days without being washed. Even then they did not then show a negative loss of head. During the summer months, when the raw water shows a high average hardness, 250 to 300 parts per million, and low turbidity, the clarification is almost perfect.

Removal of Color

Sperry[2], Chemist in Charge of the Grand Rapids water-purification plant, found that the lime which is used for softening the water also succeeds, through the removal of magnesium, in reducing the color of water to a point as low as that which could be secured at much greater expense by the application of sulphate of alumina. Two or three grains of alum were required to reduce the color from an average of 32 parts per million to an average of 10 parts per million, whereas by using enough lime to neutralize the temporary hardness, and then using enough alum (¼ grain per gal.) to drag down the fine particles of the precipitated calcium carbonate, the color was reduced to 10 parts per million, and the hardness from an average of 188 parts per million to less than 100 parts per million.

Thus both hardness and color were reduced according to Sperry's[3] figures, at a lower cost than would be required for treatment with sulphate of alumina to secure equal decoloration.

The color at Columbus by the combined use of lime, soda and alum has been reduced from an average (covering a period of five years) of 30 parts per million to an average of less than 7 parts per million.

Lime-Softened Water Not Corrosive

Lime-softened water is not corrosive to iron pipes, and since the Columbus water-supply has been softened no trouble has been experienced from accumulations of "red water" in dead ends of the distribution system.

Carbonic-acid gas has a corrosive action on iron pipe, and when this gas is neutralized by the addition of lime to the water, it loses its corrosive property.

Very soft water, containing carbonic acid, attacks lead pipe, and such waters are sometimes treated with lime to make it noncorrosive to lead[4].

Final Step in Softening Process

Following the addition of lime or soda to a hard water, two treatments are essential: (1) The water and the added chemicals must be well mixed by agitation in stirring tanks or baffled mixing tanks to get the reactions well under way; (2) the treated water must be given as much time as possible for further softening reactions to take place and for the precipitates to settle. While a large percentage of hardness is thus removed, there are two means by which a further removal of hardness may be obtained:

(1) Addition of alum. Theoretically, 1 grain of alum should remove 8½ parts alkalinity and increase the sulphate hardness by the same amount. Using this amount at Columbus it is found in practice that at times as much as 30 parts per million of carbonate hardness will be removed, and the sulphate hardness increased from 0 to 6 parts per million. During the periods when the river water is hard, alum is regularly added to the settled water in amounts ranging from ¼ to 1 grain per gal. to secure this reduction in alkalinity. The explanation seems to be as follows: Part of the magnesium present in the raw water combines with the lime to form magnesium hydroxide, which is insoluble and is deposited in the settling basins. The remainder combines with the lime and soda to form a basic carbonate of magnesium, which does not precipitate but remains in a colloidal state. On the addition of alum this colloidal magnesium is coagulated and retained on the filter sand. (2) Passage through sand filters. The residual hardness of lime-softened water may be considerably lowered in this manner. The 30-in. sand layer in the Columbus filters removes about 20% of the hardness of the applied (settled) water, when the river water is at a maximum hardness, and it was found, working on a small scale, that a bed of sand 6 ft. deep would remove as much as 40% of hardness from the applied water.

This seems to be a manifestation of the phenomenon of adsorption, or increased concentration at a boundary surface. All substances of large surface magnitude possess this property of removal of compounds from solution without any chemical reaction taking place. Among such substances are: Charcoal, fuller's earth, cloth, and various colloidal substances, such as gelatin, albumin, starch, and finally aluminum hydroxide. It is probable that the removal of hardness by alum is a process both of coagulation and adsorption.

As a result of application of alum and of passage through sand filters, the hardness of the filtered water has averaged only 89.6% of that of the settled water. Of the hardness removed, three-fourths was in the form of carbonates and one-fourth in the form of sulphates.

A recent analysis of the scale deposit from the sand showed the following results:

	Per Cent.
Loss on ignition	43.00
SiO_2	2.48
Fe_2O_3 and Al_2O_3	2.21
CaO	46.24
MgO	6.24
	100.17
Organic matter	0.88
Ca., calculated to $CaCO_3$	82.6
Mg calculated to $Mg(OH)_2$	9.0

Although the accumulation of scale on the sand grains is troublesome (as will be explained in a following paragraph) it is advisable to remove this material from the water before pumping it into the distribution system, because if it were not removed by the filters, it would very probably be deposited on the walls of the distribution system and in the meters.

[2]Paper read before the 1913 meeting of the American Public Health Association.

[3]Paper read before the Colorado Springs meeting of the American Public Health Association.

[4]See paper read by Geo. C. Whipple before the New England Water-Works Association, Mar. 12, 1913.

At St. Louis, according to Monfort[5], trouble from incrustation in pipes and deposits of scale in meters, was encountered when unfiltered lime-softened water was pumped through the distribution system.

Sections of pipe have been recently cut from Columbus mains laid in 1908, the year the softening operation began, and no incrustation is noted.

No trouble with the meters has been encountered except in those meters containing galvanized parts. A white slimy deposit of zinc carbonate formed in these meters, which clogged them and interfered with the rotation of the disks.

Troubles Encountered in Filtering Lime-Softened Water

As previously stated, the sand in the filter beds at Columbus is composed practically of two parts scale and one part sand. The sand has become so badly coated that the effective size has increased from 0.415 mm. to 0.62 mm.

The worst feature of this incrustation is due to the fact that the sand grains, after becoming coated, have a tendency to cement themselves together and form hard lumps. These lumps become as large as bushel baskets and are so hard that they have to be dug out of the bed in order to break them up.

It is necessary to shovel the sand from one filter bay to another about twice a year. This takes a force of five men about two weeks' time.

This lumping of the sand is, of course, very objectionable, as it prevents the wash water from breaking through the sand bed uniformly, and it causes the rate of filtration to be high in parts of the bed. Still the quality of the effluent is not materially affected, because the water is always sparkling clear and the bacteria, as has been explained, are eliminated by the action of the lime.

[5] "Engineering Record," May 7, 1910.

Hints for Preparing Layout Plans for Bridges on Curve

By C. M. Luther*

SYNOPSIS—Factors of a bridge on curve which require arbitrary determination are tilt of girders, location of axis, slope of bridge seats, angle between ends and axis, etc. The engineer must fix these matters before design can proceed. Various actual cases show their bearing on the design.

While the stress-analysis of railway bridges on curves has received adequate attention in technical literature, the preparation of layout plans for such bridges has been neglected. The results of this neglect are often painfully apparent. Therefore, a brief discussion of layouts of bridges on curves, and especially the relation of plate-girders to masonry, may be of some interest.

The eccentricity of the center line of track with respect to the axis of the bridge is an important factor in deciding the distance between centers of the girders, and has a direct bearing on the design of the masonry. It is generally conceded that for all practical purposes the right bisector of the middle ordinate of the span may be taken as the trace of the central plane between girders on the plane of the ties. In other words, this bisector is considered to be the axis of the bridge, or the center line between girders, at the elevation of base of (lower) rail.

The simplest case of a bridge on curve is that of a single-span deck plate-girder bridge on simple curve. If the curve is quite flat, and the span short, so that the middle ordinate for the span does not exceed ½ in., the chord of the span may be considered as the axis of the bridge at the plane of the ties; otherwise, the above-stated method should be used. Fig. 1 shows the general layout of a bridge on a 5° curve, in which the middle ordinate for the span is over 13 in. The length of the girders is 100 ft. out to out, and the chord length between the ballast walls 100 ft. 8 in., there being 4 in. between the end of the steel and the face of masonry at each abutment. The distance from the base of (lower) rail to the bridge seat is 12 ft. 2 in. In single-span

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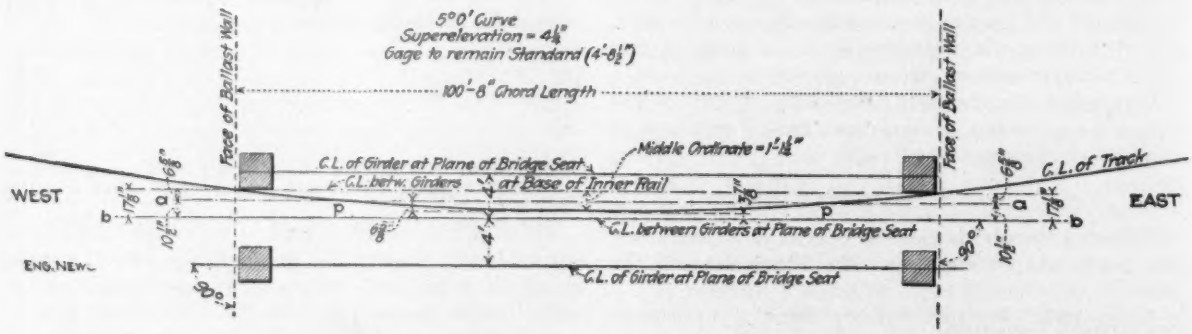
5°0' Curve
Superelevation = 4½"
Gage to remain Standard (4'-8½")
100'-8" Chord Length
Face of Ballast Wall
Face of Ballast Wall
Middle Ordinate = 1'-1½"
C.L. of Girder at Plane of Bridge Seat
C.L. betw. Girders at Base of Inner Rail
C.L. of Track
WEST
EAST
C.L. between Girders at Plane of Bridge Seat
C.L. of Girder at Plane of Bridge Seat
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Fig. 1. Plan of Single-Span Deck Plate-Girder Bridge on 5° Curve

bridges, where the crossing itself is not skewed, it is undoubtedly the best practice to have the ballast walls at right angles to the line *a-a* (Fig. 1), and hence to the center lines of the girders. This insures girders of equal length.

The sketch shows two lines designated as center line between girders, *a-a* at the elevation of the base of (lower) rail, and *b-b* at the plane of the bridge seat. It is evident that when the girders are tilted (with an inclination to the vertical equal to the slope of the ties), the offset from the center line of track to the central plane between girders, *at the ends of the span*, will increase with the depth of the girders, attaining the maximum at the plane of the bridge seat, while the central plane between girders will, at the elevation of the bridge seat, approach the curve between points *P-P* (Fig. 1); and as a matter of fact, where the depth of the girders permits, it will even pass outside the curve, as is the case in Fig. 1. The importance of stating clearly, on the layout diagram, the position or elevation at which the center line between girders is taken, cannot be emphasized too strongly.

Therefore, after the center line of track is projected on the bridge seat, the center line between girders at that elevation must be located with respect to the center line of track. This being done, the correct position of the masonry plates and bolt holes on the bridge seat can readily be marked.

Fig. 2 is a section of the girders of Fig. 1, at the bridge seat of the west abutment. The total superelevation of the outer rail is 4¼ in., which corresponds to a train velocity of 36 mi.p.h. This superelevation gives the ties a slope of practically 1:14. In this bridge, the girders are inclined to the vertical with the same slope, so that the plane of the girder web is perpendicular to the plane of the ties; this eliminates the extra notching of the ties, and insures even bearing for them on the top flange.

In the abutments for this bridge, the bridge seat is made level, which leaves the entire slope of 1:14 to the shoes. The ballast walls, of course, following the ties, will also have a slope of 1:14. The abutment obviously is not symmetrical about the center line between girders.

In bridges requiring only a very flat slope of ties, the bridge seat of the abutment or pier may be made parallel to the plane of the ties. In that case the masonry members under both girders will be of equal depth.

Fig. 3 is the section of a half-through plate-girder bridge, at the end of the span. It is on a 5° curve; the girders are 63 ft. long and are spaced 15 ft. c. to c. The slope of the plane of the base of rail is 1 in 16, which

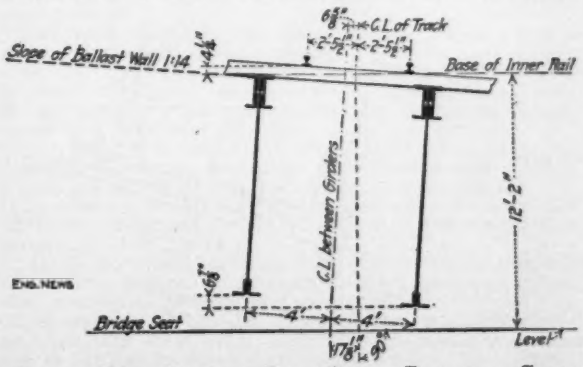


Fig. 2. Cross-Section, Deck Girder Bridge on Curve

very nearly gives a superelevation of 3¾ in. This slope is distributed between the bridge seat and the underside of the ties, the former taking two-thirds of the total slope and the latter one-third. This arrangement, in this bridge, is due to the Canadian Allis-Chalmers, Ltd. (formerly Canada Foundry Co., Ltd.). If the superelevation were small, the bridge seat could have been made level, leaving the entire slope to the ties, which would have been dapped to the required bevel over the stringers.

It will be noticed that in Fig. 3 the stringers are located symmetrically with respect to the center line between girders. But theoretically the axis of the stringers is eccentric with respect to the axis of the bridge. While for short spans and flat curves, it is permissible to have the axis of the stringers coincide with that of the bridge, it is advisable for sharp curves and long spans (particularly in trusses, in which the floorbeams are spaced farther apart) to consider the panel length between the floor-beams as individual spans with respect to the stringers, and provide for the necessary offset.

In multiple-span bridges on curves, it is a good practice to have the faces of the ballast walls and the center lines of the piers normal to the curve, as shown in Fig. 4. They must be located clearly in reference to a definite line, say to the tangent at one end of the bridge. In

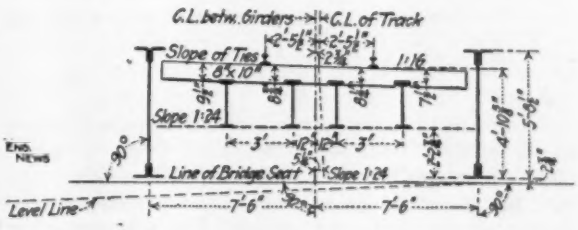


Fig. 3. Cross-Section of Half-Through Bridge on 5° Curve

(Two-thirds of slope in bridge seat, one-third in notching of ties.)

this layout, there will be two sets of girders, the inner and outer girders. The excess of the theoretical length of the outer girder over that of the inner may be expressed by the formula $E = 2\,H \tan \frac{1}{2}\,I$, where E is the excess, H the distance center to center of girders, and I the central angle of the span.

When the curve is rather flat, and the number of the spans comparatively few (three or four), the faces of the ballast walls and the center lines of the piers may all be made perpendicular to the long chord of the bridge. In that case, all the girders will be of same length theoretically, and the piers and abutments will be parallel to each other. But the angle between the center line of girder and the center line of pier will be different for each span, which is an obvious disadvantage.

In very few cases, where a bridge on curve crosses a street, a railroad, a canal, and other similar traffic channels, all at the same place, it becomes necessary to have all the piers parallel to each other and form an oblique angle with the long chord of the bridge. But this layout, for bridges on sharp curves and having more than five or six spans, should be avoided whenever possible, as it means a sharper angle of skew and longer piers at one end of the bridge, and the whole structure will have an unsightly appearance.

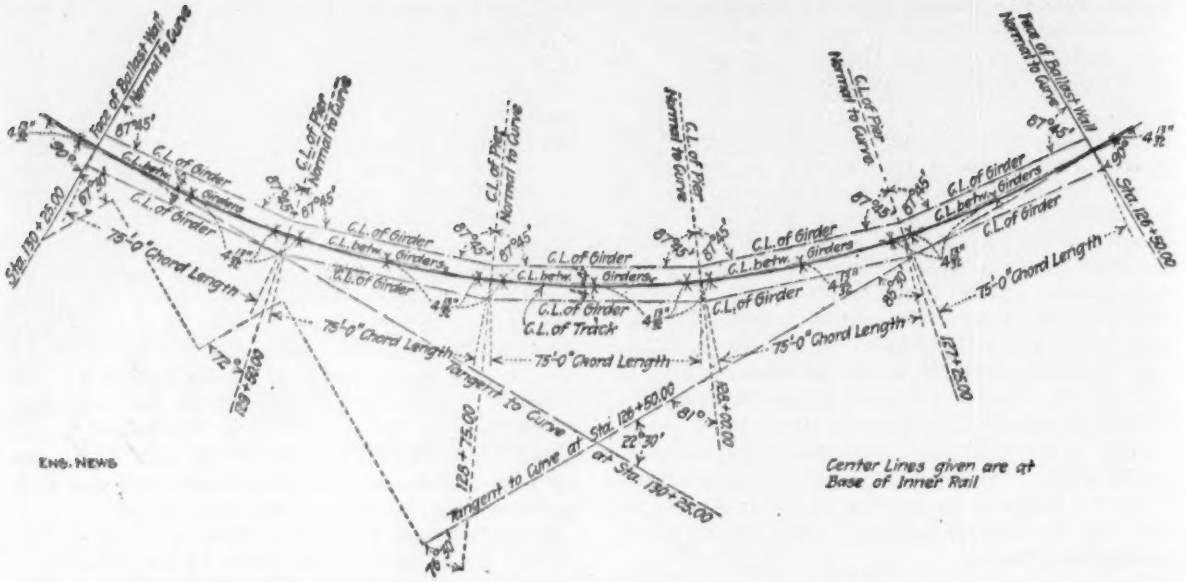


FIG. 4. LAYOUT DIAGRAM FOR MULTIPLE-SPAN DECK PLATE-GIRDER BRIDGE ON 6° SIMPLE CURVE

In steel viaducts, on curves, the transverse center lines of the pedestals should be at right angles to the chord of the tower span, i.e., the central plane between bents should be normal to the curve. With this arrangement, it is easier to have the base of the tower nearer the true rectangle; and, if the pedestals have the same elevation on top and the bents the same batter, there will be no skew connections in the framework of the tower. To have the transverse center lines of the pedestals normal to the curve must be condemned. Fig. 5 is the layout diagram of part of a viaduct on a 4° curve.

When a bridge is on transition curve, the same principles may be practiced in determining the center line between girders. It must be borne in mind, however, that the maximum ordinate will not occur at the middle of the span. When the bridge is on the sharper end of the transition curve, and the span is long, this feature must be taken into consideration, and the station where the maximum ordinate will occur must be located. Fig. 6 is the layout of a deck plate-girder bridge on the spiraled approach of a 6° curve. The easement curve is assumed to be a "cubic spiral." The offsets at the beginning and the end of the span, and at the point where the maximum ordinate will be, have been figured by the aid of the well known formula $x = \frac{d^3}{6RL}$ where x = the offset from the spiral to the initial tangent at the end of the first spiral-chord, d = length of the spiral-chord (40 ft. in Fig. 6), L = total length of the spiral, and R = radius of the circular curve. The offset at any other point, say S ft. from the beginning of the spiral, would be $x\left(\frac{S}{d}\right)^3$.

To find the point of the maximum ordinate to any span on the spiral:

Let

C = chord length of the span;

F = larger offset from one end of the chord to initial tangent;

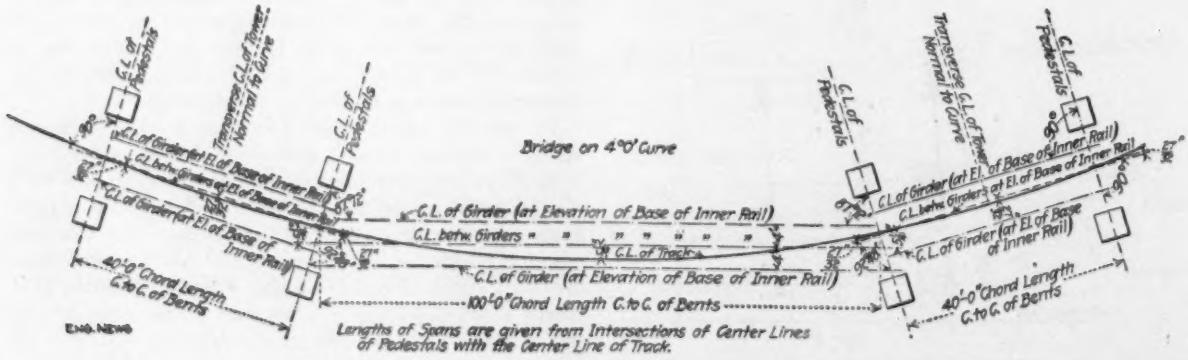
f = smaller offset from other end of the chord to initial tangent;

l = distance from beginning of spiral to the required point;

Δ' = central angle of the spiral for length l;

Δ = central angle of (total) spiral for length L.

Then $\Delta' = \sin^{-1}\frac{F-f}{C}$. This means, of course, a deflection angle of $\frac{1}{3}\Delta'$ from the beginning of the spiral to the


C.L. of Pedestals
Transverse C.L. of Tower Normal to Curve
Bridge on 4°0' Curve
C.L. of Girder (at El. of Base of Inner Rail)
C.L. betw. Girders at El. of Base of Inner Rail
C.L. of Girder (at Elevation of Base of Inner Rail)
C.L. betw. Girders
C.L. of Track
40'-0" Chord Length C. to C. of Bents
100'-0" Chord Length C. to C. of Bents
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Lengths of Spans are given from Intersections of Center Lines of Pedestals with the Center Line of Track.

FIG. 5. LAYOUT DIAGRAM FOR VIADUCT ON CURVE

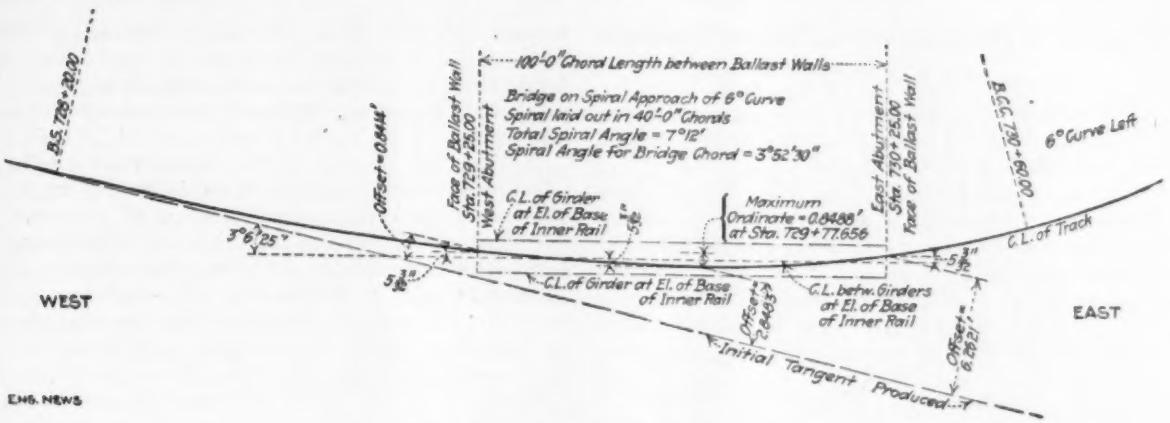
100'-0" Chord Length between Ballast Walls
Bridge on Spiral Approach of 6° Curve
Spiral laid out in 40'-0" Chords
Total Spiral Angle = 7°12'
Spiral Angle for Bridge Chord = 3°52'30"
B.S. 728+30.00
Offset = 0.844'
Face of Ballast Wall Sta. 729+25.00 West Abutment
C.L. of Girder at El. of Base of Inner Rail
Maximum Ordinate = 0.8488' at Sta. 729+77.656
East Abutment Sta. 730+25.00 Face of Ballast Wall
B.C.C. 730+60.00
6° Curve Left
C.L. of Track
3°6'25"
5 3/8"
5 3/8"
WEST
C.L. of Girder at El. of Base of Inner Rail
C.L. betw. Girders at El. of Base of Inner Rail
Offset = 2.843'
Offset = 0.252'
EAST
Initial Tangent Produced
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FIG. 6. SINGLE SPAN ON SPIRAL

required point. With these in hand, the station of the point can readily be computed, and the other elements determined.

Again, since the central angles, for different portions of the spiral, taken from the beginning of the spiral to its end, vary as the squares of the distances, the formula, $l = \sqrt{\frac{d' L^2}{d}}$ will at once give the station of the point required.

Regulations for the Sanitary Protection of the Sources of Water-Supply of Tacoma, Wash.

Strict rules for the sanitary protection of water-supplies drawn from surface sources are becoming more and more common. As an example from the far West we reprint the following from an ordinance of the city of Tacoma, Wash., passed April 2, 1913, which applies to the entire area of Green River above the water-works intake dam:

Sect. 1. The following sanitary regulations are hereby established to be observed by the inhabitants of the watershed of Green River, in King County, being all the areas of land draining into the lakes, rivers, springs, streams, creeks and tributaries flowing and emptying into said Green River above the dam constructed in Sect. 18, township 21 north, range 8 east, to wit:

(1) Every employer of labor, head of a family, hotelkeeper and lodging-house keeper within said watershed shall forthwith, upon ascertaining that any person on his premises is ill from any disease, notify the chief of the Green River police thereof.

(2) Each physician who shall attend a patient afflicted with a contagious or infectious disease within said watershed, shall forthwith notify the health officer of the city of Tacoma thereof; if no physician shall be attendant, the head of the family or other person having the care of the patient so afflicted, shall give the notice above provided for.

(3) The health officer and Green River police shall enforce all reasonable quarantine rules necessary to prevent the spread of any such contagious or infectious disease, and their orders in such respects shall have the same force and effect as similar quarantine regulations in the city of Tacoma.

(4) Every person suffering from typhoid fever, or other water-borne disease, within said watershed, shall be removed to a hospital in the city of Tacoma and there treated free of expense to such persons: Provided, That where such person has been contributing hospital dues to his employer, and is entitled to hospital treatment therefor, his removal and treatment shall be at the expense of the fund thus provided.

(5) No person shall cast into the flowing waters of said watershed, any garbage, manure, excreta, decayed vegetable or animal matter, or other rubbish; nor upon the ground within 500 ft. of the same; but all said material shall be burned up or else removed to the distance above prescribed.

(6) No person shall wade or bathe in any of the flowing waters of said watershed, or permit any animal to stand or wallow therein.

(7) All toilets and privies within said watershed shall be equipped with water-tight receptacles of proper size and permanent construction, and be so arranged as to enable them to be easily emptied or pumped out. Any such toilet or privy not so equipped may be condemned by the chief of the Green River police, and the defect shall thereupon be remedied by the owner or occupant of the premises within five days. When any such toilet or privy requires to be emptied or pumped out, the work shall be done under the supervision of the Green River police and to the satisfaction of the chief.

(8) Every employer of labor shall provide portable sanitary toilets and require the use of the same by employees doing work at a distance from their permanent camps or dwellings, and at any place within 1000 ft. of Green River or any of the lakes, springs or streams tributary thereto.

(9) No trespasser upon land not his own within said watershed shall camp or hunt upon such lands or fish in the waters of Green River or of any lake or stream tributary thereto, where they run or lie within such land.

(10) No unauthorized person shall remove or destroy any notice or sign posted in said watershed by the health officer of the city of Tacoma, or by his order in aid of preventing the pollution of the waters of said Green River.

The penalty for the violation of the ordinance is a fine of not more than $100 or a county jail term not exceeding 30 days, or both a fine and imprisonment.

The Garbage Collection and Disposal system for Chicago, as recommended by the City Waste Commission, was reviewed in our issue of April 9. The recommendations were adopted by the City Council in June, and appropriations were passed to provide for a technical staff to develop, install and commence the operation of the system, and to provide for the necessary plant. The plant already provided for includes the following: A reduction plant and incineration plant adjacent to the present reduction plant on the Chicago river at 39th St., $35,000; two incinerator plants at Goose Island and at Austin and Claremont Aves., $50,000 and $37,000; combined reduction and incineration plant (for unseparated garbage) at 95th St. and Stony Island Ave., $100,000.

The Commission recommended the disposal of garbage at a central reduction plant; the use of ashes and non-combustible waste for filling low ground; and the disposal of combustible waste at small incineration plants, one at the loading station of each of the 14 collection districts. An exception to this was a combined reduction and incineration plant at 95th St. (noted above) to serve two southern districts. The separation to be done by householders, metal and glassware to be recovered by sorting waste at the loading stations, and all the work of collection, transportation and disposal to be done by the city. Dr. Willis O. Nance (Alderman) is Chairman of the Chicago City Waste Commission.

Water Softening at Port Tampa

By Hiram McElroy*

The problem of good water for drinking and domestic purposes has been one of great difficulty in Port Tampa, Fla., ever since its first settlement.

During the early eighties, the Plant System, now known as the "Atlantic Coast Line Railway," built its lines into this territory and established its terminals at Port Tampa, where an abundance of deep water prevailed. Many thousands of dollars were expended from time to time in an attempt to secure water for boiler purposes, drilling no less than 25 artesian wells. An abundance

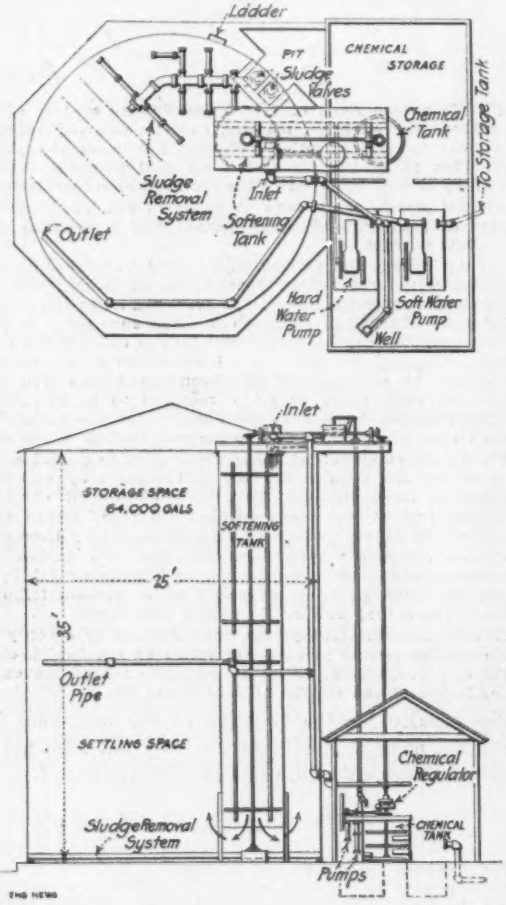

Fig. 1. General Design of Water-Softening Plant, Port Tampa, Fla.

of sulphur water was easily obtained at a depth of 60 to 80 ft., but the quality was so unsatisfactory that its use in boilers or for other purposes was prohibitive. The entire country about Port Tampa and several small lakes across Old Tampa Bay were fully investigated but with no apparent success. In the meantime, water had to be transported in tank cars from the upper parts of the state for the use of engines and shops and to supply the great ocean steamers.

At the time of the Spanish-American War, with 25,000 troops to handle through Port Tampa, together with thousands of horses to be loaded for the campaign against Santiago, the problem of securing even drinking water was perhaps the most serious menace facing the United States Government. A considerable portion of the sickness prevailing among our troops was doubtless due to this cause.

During 1910, the City of Port Tampa erected a municipal water-works plant for domestic and other uses. This plant has been very largely a failure, due to the very hard and ill smelling sulphur water. The citizens had very generally abandoned its use and resorted to the erection of tanks to be filled by rain water from the roofs of the houses, affording an excellent breeding place for mosquitos. About the only use for the water plant was as a protection against fire.

In view of this condition, it became apparent to the city council that if the plant was to be commercially successful, a softer water must be furnished to its patrons. In March of the present year, the city council retained the writer as consulting engineer to investigate and report on what could be done to improve the city water-supply. The result of the investigation was a recommendation that a water-softening and purifying plant be installed in accordance with plans and specifications submitted. A contract was entered into with R. L. Davis, of Tampa, Fla., for the erection of such a plant, to be equipped with water-softening machinery furnished by the L. M. Booth Co., of New York.

The softening plant was put into operation in June of this year. Its constructin is very simple and the plant may be said to operate automatically. No additional labor is required, the regular pumpman doing the entire work.

Fig. 1 shows the general design and Fig. 2 is a general view of the plant as constructed. The plant has a capacity of 10,000 gal. per hr. of softened water and was installed complete at a cost of approximately $7000, including a storage capacity of 190,000 gal. of softened water. All equipment of the old plant was utilized.

Details of Operation

The water which is to be purified is taken from a 6-in. well 90 ft. deep, located in the pumphouse. It is delivered to the inlet box on the top of the softener by a gasoline engine and pump. The well pump, in addition to supplying the hard water to the softener, furnishes also the power to drive the agitators, an extension of the flywheel shaft serving as the driving pulley.

The chemical solution required to treat the raw water meets the water in the top of the softening tank. This is equipped with mechanical agitators and has a volume corresponding to from 16 min. to 32 min. flow when the plant is operated at full capacity of 10,000 gal. per hr. The reason that the period of retention in the softening tank can be variable, although the plant is run at the given rate of flow, is because the storage space above the outlet may contain varying quantities of water due to the widely fluctuating demands. Above the outlet, there is storage for 64,000 gal. of softened water. This is available for instant use even though no raw water at the time is being pumped into the softener. It is, of course, the intention to maintain the tank nearly full at all times.

The function of the softening tank is to thoroughly mix the chemicals with the down-flowing water to insure that there will be no waste or loss of purifying chemicals. The mechanical agitation is an additional benefit in that it coagulates the precipitated impurities so that these will

*City Engineer, Port Tampa, Fla., with offices in Tampa, Fla.

quickly settle out as soon as the quiet of the settling space is reached.

The rate of upflow from the bottom of the softening tank to the outlet in the settling space of this softener is 2.85 ft. per hr. This is sufficiently slow to effect a thorough clarification.

Suction for the soft-water pump is taken through the outlet pipe, 17 ft. above the foundation, which is at the bottom of the storage space. The soft-water pump delivers the softened water into a 60,000-gal. elevated steel tank mounted on a steel tower 125 ft. high, from which it is distributed to the city mains.

All of the work of attendance, except lubricating the shaft bearings on the top of the softener, is done at the ground level. The chemical tank (Fig. 3) is located in the chemical storage room of the pump house, so that it

ANALYSIS OF WATER BEFORE AND AFTER SOFTENING, PORT TAMPA, FLA.

(Grains per U. S. gal.)

	Before	After
Calcium carbonate	16.62	0.31
Calcium sulphate	0.35	....
Calcium chloride	13.10	....
Calcium hydroxide	....	0.78
Magnesium chloride	4.78	....
Magnesium hydroxide	....	0.24
Iron oxide	0.33	0.12
Alumina		
Silica	1.66	0.93
Suspended matter	0.25	....
Incrusting solids	37.09	2.38
Sodium carbonate	....	2.15
Sodium sulphate	....	0.38
Sodium chloride	28.63	48.30
Nonincrusting solids	28.63	50.83
Free carbon dioxide	0.66	....
Half-bound carbon dioxide	7.31	....
Volatile matter	7.97	....

FIG. 2. GENERAL VIEW OF PORT TAMPA WATER-SOFTENING PLANT

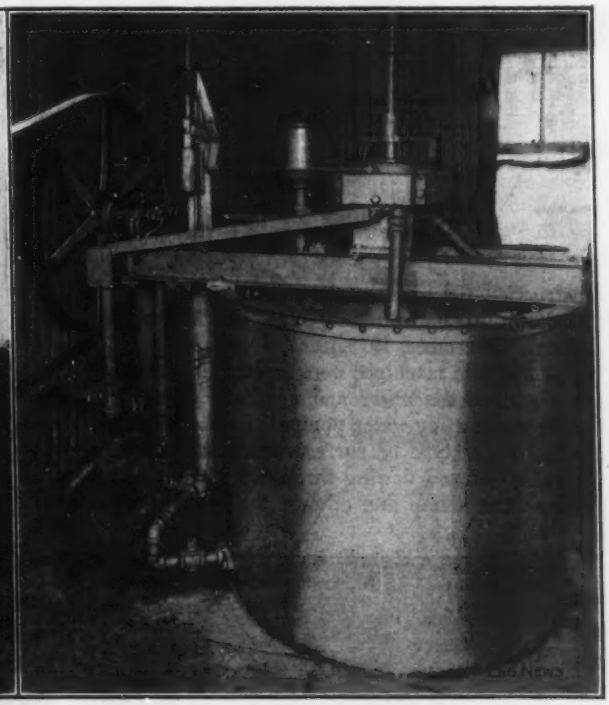

FIG. 3. CHEMICAL REGULATOR AND TANK, PORT TAMPA WATER-SOFTENING PLANT

takes only a few minutes for the attendant to prepare the day's supply of chemicals. The proportional feeding of the chemical solution is controlled by a Booth automatic chemical-feed regulator.

The sludge-removal equipment consists of two sets of tile-pipe systems, each of which terminates in an 8-in. quick-opening gate valve. The sludge removal draws the precipitated impurities through 77 one and one-eighth-in. openings distributed over the bottom of the settling space. By the use of this system, the sludge is blown off each day. Only a small quantity of water, just enough to convey the precipitate, is used.

The chemicals used to soften the water are 2½ lb. of hydrated lime and 2.25 lb. of 58% soda ash, costing 3c. per 1000 gal.

The accompanying table shows the analysis of the water both before and after softening:

The use of the softened water by many of the citizens of Port Tampa demonstrates beyond all question that the water softener is not only performing its function of rendering the water fit for domestic and laundry uses but has entirely removed the offensive odor and taste of the water. Instead of being compelled to put up with a vile, ill-smelling and bad-tasting sulphur water, the city is now supplied with a clear, sparkling liquid, free from its former objectionable minerals and bacteria.

Steel Passenger Cars for Indian railways are said to be under consideration by some of the railway companies, owing to the increasing price of teak wood and the decreasing price of steel. At present, steel freight cars are used extensively, and the modern passenger cars have steel underframes with wood bodies. In view of the intense and continued heat, special means of insulation and ventilation would be required for steel bodies of passenger cars.

1000-HP. Steam-Turbine Pumping Units in Charlottenburg, Germany

There are three 1000-hp. steam-turbines driving centrifugal pumps, in the Berlitzhof stations of the Charlottenburg Water Works, which are of interest for comparison with recent American practice. (These units were described in more detail in some notes on turbine construction for water-works service by B. Rosenfeld in "Fordertechnik," November, 1913, and in the "A. E. G. Journal," December, 1913.)

The first two machines were erected in Station 2; each has a surface condenser and auxiliary turbine to drive the air and cooling-water pumps. In the third machine, a water-works type of surface condenser was used—all the water pumped flowing through. This eliminates the cooling-water pump and allowed the air and condensate pump to be driven from the main turbine—which gave the advantage of higher economy to the auxiliaries. The air ejector is direct connected to the turbine shaft and is on the same bedplate with main pump and turbine. The condensate pump, below the condenser drain is on a vertical shaft driven by the main shaft through bevel gears.

The water enters the condenser (placed immediately below the unit) from the front and is taken out at the back up to the main-pump section inlet. In starting, the pump is primed by a steam injector. The machine can be started from the upper floor as the only machinery in the basement requiring care is the geared condensate pump and this needs no special attention in starting. The vacuum is increased as the turbine advances to normal speed. Only some three to five minutes is required for starting.

The pump has a capacity of 10,550 gal. per min. (15.2 million per 24 hr.) at lifts of 197 to 344 ft. The guaranteed duty for this capacity varied from 131 million foot-pounds per 1000 lb. steam (155 lb. gage pressure and 600° F.) to 154 according to the lift. The acceptance trials were made at 285-ft. head and the above delivery when the guaranteed figure was exceeded by some 9%.

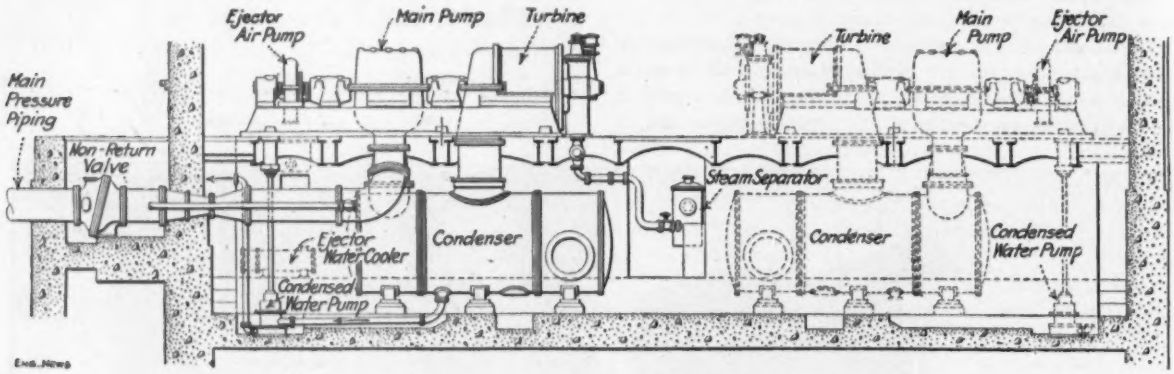

FIG. 1. ELEVATION OF BERLITZHOF PUMPING UNIT

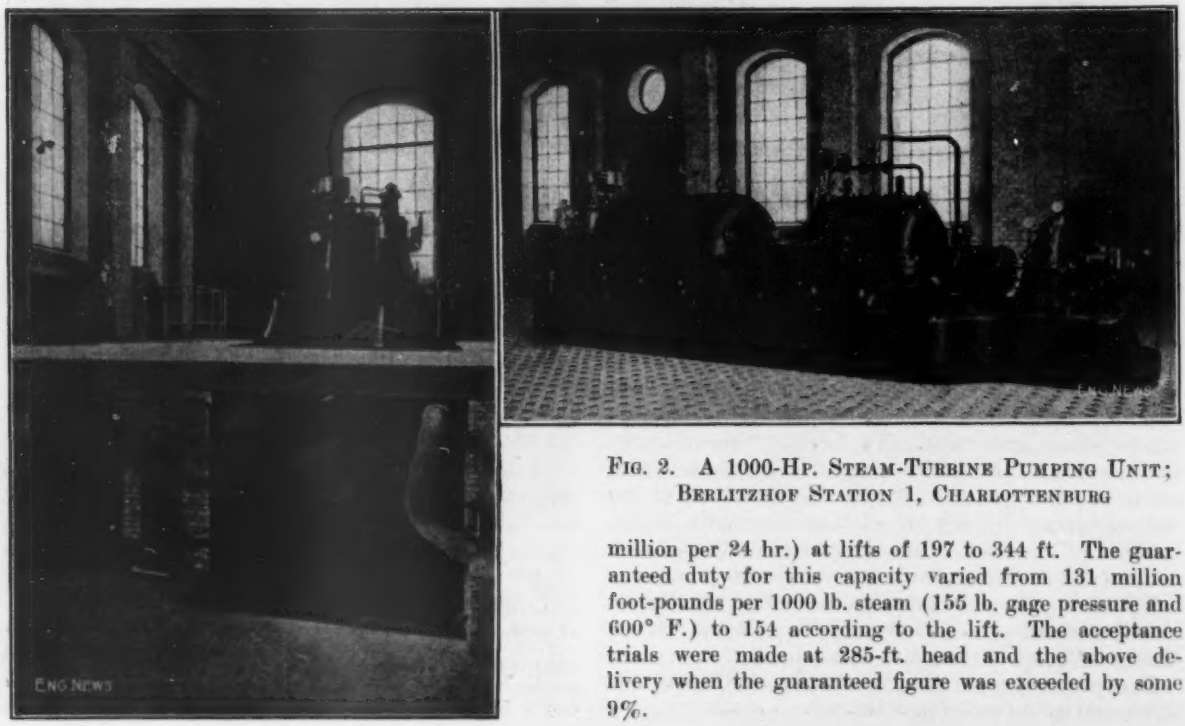

FIG. 2. A 1000-HP. STEAM-TURBINE PUMPING UNIT; BERLITZHOF STATION 1, CHARLOTTENBURG

Editorials

Solid British Water Tank Engineering: 1793--1914

The recent demolition of the old water tank of the Manhattan Co., New York City (ENG. NEWS, July 23, 1914) should not be passed by without noting that cast-iron water tanks are not only in common use in England today, but are still being constructed; at least they were only a few years ago and it seems fair to infer from a current advertisement that they still are. At the risk of embarassing American manufacturers of steel tanks by foreign competition from cast-iron tank makers, we reproduce with space reduction the following advertisement from the "Engineering Supplement" of the London *Times*.

CAST
IRON
TANKS.

LARGEST MAKERS IN
THE UNITED KINGDOM.

DRAWINGS, SPECIFICATIONS,
AND ESTIMATES ON
APPLICATION.

CONTRACTORS TO THE
ADMIRALTY, WAR OFFICE,
AND CROWN AGENTS.

NEWTON, CHAMBERS & CO., LTD.
THORNCLIFFE IRONWORKS NEAR SHEFFIELD

ESTABLISHED 1793.

It will be noted that the ironworks named was established in 1793. We have assumed in the heading to this note that it has been making cast-iron water tanks for a century. It would probably be equally safe to assume that it will continue the practice for another hundred years—and that the tanks will defy the elements for that length of time.

Why cast-iron water tanks, like pipe of the same material, were not widely introduced from England to the United States would be an interesting but not otherwise profitable subject for discussion. Suffice it to say that before metal water tanks were in great demand here, first wrought iron and then steel plates were readily available, and that where, as was so often the case, long railway hauls to the site and considerable artificial elevation were necessary for the tanks where there were obvious reasons for using lighter material than cast iron. At the same time British ideas of solid and durable engineering construction have led to a continuation of the use of a material and form of water-tank construction which seems in this country to be so much a relic of the past as to warrant the illustrated article on the old tank in New York City to which we referred in our opening paragraph.

We call attention to this contrast in British and American practice in no spirit of criticism, but simply as a matter of passing interest.

Color Decoration for Concrete Bridges

It is not so long since it was apparently a fundamental of bridge design that ugliness is a necessary accompaniment of strength. Happily, that day is gone, and the bridge engineer is now well aware that there is nothing essentially unmanly in accepting some of the architectural concepts of beauty, particularly in the design of concrete bridges, which lend themselves more readily to architectural treatment than steel bridges of more obvious structural composition. At the same time, such artistic treatment has been confined almost solely to disposition of line and mass and has only rarely invaded the field of decoration. Of the use of color decoration, the bridge designer has been especially chary, confining his efforts in that direction to some broad contrasts of mass color, such as the yellow and gray concrete faces of the Connecticut Ave. Bridge at Washington, or to some specially selected aggregate exposed in contrast, as at the Walnut Lane Bridge in Philadelphia.

Of late, there have been a few attempts at radical color decoration by the use of inset tile placed in pleasing line and form on exposed surfaces. One such bridge in which the decoration was on the exposed spandrel wall was built last year at Chicago, and was described in ENGINEERING NEWS some months ago. Another, and more radical example, is the railing of the 66th Ave. bridge at Philadelphia, described on the first page of this issue. The very pleasing effect gained in the Philadelphia bridge is well shown by the views which we print, although the tasteful contrast of color cannot be conveyed by the black and white reproduction. The views are sufficient, however, to demonstrate that, with proper care, and in the proper location, colored tile can be very effectively used to relieve that bareness of line with which concrete is always most economically placed.

The Military Value of Aerial Navigation

The rigid restrictions placed by the military authorities of Europe on the publication of news relative to the events of the war will delay for a long time the gathering of exact information concerning many questions which have hitherto been controverted and which this war is expected to settle.

A whole array of new weapons for attack and defense, by land and by sea, have been developed during the last dozen years and their efficiency is now being tested for the first time. In case a gigantic naval conflict should oc-

cur during the war, the question may be settled whether the naval policy of the future will be to continue the building of the so called superdreadnoughts or still huger and speedier floating fortresses, or whether these great engines of warfare shall be superseded by smaller and handier ships, of which perhaps ten times as many could be built for an equal expenditure. Until the war is over, however, no detailed account of the behavior of naval vessels in action is likely to be made public.

A certain amount of information, however, is already obtainable bearing on the controverted question as to the value of aërial navigation in warfare. The news is fragmentary and indefinite, it is true, and much allowance must be made for exaggeration. All that has appeared, however, indicate that, as was suggested in these columns years ago, the military value of aërial navigation has been greatly overestimated in the popular mind. Its greatest value by far, without doubt, is for scouting purposes, to obtain information as to the disposition of an enemy's forces. To what extent the aëroplane operators have been successful in obtaining this information under varying conditions of wind and weather is likely for some time to come to remain a military secret with the chiefs of the contending nations.

As for the use of aëroplanes or dirigible balloons for actual attack, by dropping bombs on cities, forts or ships, it does not appear, from all accounts, that anything important in the way of actual destruction has yet been accomplished in this way. A certain value must be allowed, of course, to the panic produced by the appearance of a hostile aëroplane or dirigible over a city and the dropping of bombs upon it. On the other hand, the amount of destruction which it is possible to accomplish by this means has been demonstrated to be comparatively insignificant and can have, strictly speaking, no military value. Both aëroplanes and dirigible balloons have to fly at such a great height in order to escape prompt annihilation from long-range rifles and machine guns that if they drop bombs, it must be done haphazard for the most part and with little chance of hitting a definite object. On the other hand, the navigators of attacking airships have suffered fewer casualties than might have been expected during their flight over hostile cities, since it was soon found that the danger to those in the city from a hail of bullets directed at aëroplanes at a great height was greater than the danger from any bombs which the navigators might drop.

The Loss of German Products

It is only giving credit where credit is justly due to say that there is probably no other nation in the world whose sudden isolation commercially would cause such widespread loss as has been caused by the isolation of Germany. It is appropriate that this should be recorded here because Germany more than any other nation has won its important place industrially, not by reason of its wealth of natural resources or its geographical location, but by the skill and intelligence with which its people have attacked modern technical problems.

While engineers and chemists are generally aware of Germany's leadership in the field of science and technology, the events of the past few weeks have been a great object lesson to the general public. Few have realized the extent to which the whole world has relied upon German scientists, chemists, engineers and manufacturers, for the supply of many materials necessary in the arts. Manufacturers in America and in England who were congratulating themselves on their enlarged opportunities for foreign trade in markets where the supply of German goods was cut off have in not a few cases found their own productive operations seriously hampered because they could no longer obtain certain materials from Germany.

As is well known, steel manufacturers were greatly worried to know what they were to do for their supply of ferromanganese. Manufacturers of fertilizers have had to face the possible shutdown of their works through the cutting off of the supply of German potash. In the textile industries, manufacturers suddenly realized that with access to German ports blockaded by warships there was every prospect that the supply of dyes and dyeing materials would be seriously interfered with. In the drug and chemical trade, prices doubled and trebled when it was realized that with further supplies from Germany cut off, the world would have to get along for a time without certain drugs and chemicals which have become well nigh essential both in the pharmacy and in certain industries.

The above list might be greatly extended. It is in fact only a statement of a few of the important staples, in the production of which Germany has been so preëminent that all the rest of the world has relied upon her to furnish them.

Surely, from a broad point of view, the victory which Germany has gained over the nations of the earth by its leadership in the conquest of the most difficult fields of industrial technology actually surpasses as a meritorious achievement any victory which its great military organization may gain by brute force.

It is said that most of these things for which we and other nations have been accustomed to rely upon Germany, could be produced here if necessary. This is true as relates to most of these materials, provided sufficient time were available, but sufficient time in most cases is a very long time. In the fertilizer trade, for example, investigations have been in process for a number of years looking to the production of potash from natural sources in the United States. But what has been actually accomplished commercially is the merest trifle compared with the demand which must be supplied. To develop plants which will produce the amout of potash required by the fertilizer trade and other consumers in the United States, and at a cost consistent with commercial necessities would require not months but years. Farmers and fertilizer manufacturers are anxious to know what they are to do in the meantime.

The same thing holds true of numerous materials in the dye and chemical trades. Physicians and druggists accustomed to use some of the varied products of coal tar, most of which have originated in and are solely produced by Germany, are in a quandary to know what they can do if the source of supply is entirely shut off.

It is of particular interest to note, moreover, that the manufacturers of England, Germany's great commercial rival, and present enemy, are almost as badly hit as those of the United States by the cutting off of the supply of German products. Our English exchanges reveal that while English manufacturers are making large plans for capturing the export trade in many lands which Germany cannot now reach, they find themselves handicapped at every turn by the cutting off of supplies which

they themselves have been accustomed to obtain from Germany.

Fortunately, the war has not yet closed all the avenues by which Germany can send out its product to the world. Through Holland, a neutral nation, shipments from Germany can reach tidewater and be distributed by neutral vessels.

Of course, the drafts on Germany's male population for the army have paralyzed a large part of Germany's industrial activity, but since an underlying motive of the war is the maintenance of the nation's commercial prestige, it cannot be doubted that Germany will use every effort to continue to supply her foreign customers, so long as any channels for the outlet of her exports remain open.

Cutting Down the River and Harbor Appropriations

It is a pity that the pressure of war news in the newspapers has prevented practically any public mention of the splendid fight which has been waged by Senator Burton, of Ohio, to eliminate from the River and Harbor Bill many millions of dollars of appropriations provided for worthless projects. The Federal government finds its income reduced at the rate of $100,000,000 per annum as a result of the European war. Instead of cutting down its expenditures, however, to correspond to this reduced income, it proposes to make up the deficit by laying additional taxes upon the public, and this at a time when taxpayers the country over are likewise feeling the effects of the war in reduced earnings and increased cost cost of living.

There are government expenditures which can hardly be cut down, but many of the items in the pending River and Harbor Appropriation Bill, as Senator Burton well showed in his keen analysis before the Senate, are as absolute a waste of money as if the gold were taken and thrown into the sea.

Of course, these items are defended on the plea that the expenditure of money by the government makes business for contractors engaged on government work and for firms who furnish their supplies and for the labor which they employ. This, however, is far from being a valid defense for the government expenditure; for if the government left this money in the hands of the taxpayers instead of collecting to spend on rivers and harbors, the taxpayers themselves would lay it out in the employment of labor, so that no more labor is employed in the one case than in the other.

It is now proposed to provide the additional revenue which the government requires, to the amount of $65,000,000, by collecting a tax of 3% on every freight bill paid. This, it is estimated, would yield in a year $65,000,000, or just about what the government proposes to spend next year on river and harbor improvements bill. Nothing could be clearer than the fact that if the railways were allowed to charge this 3% additional increased rates there would be in the railway treasuries during the year $65,000,000 more money available for works of permanent improvement. The contractors and their workmen would be employed on railway work instead of on waterways. As to the comparative public benefit of spending $65,000,000 on railway improvements and the same amount on river and harbor projects of the class condemned by Senator Burton, there could hardly be two opinions in the mind of well informed engineers.

The essential difficulty with the River and Harbor Bill, of course, and one which Congressmen themselves frankly recognize, is that it is in large part a "pork barrel" bill. A member of Congress or a senator is chiefly concerned to obtain a Federal appropriation to be expended among his constituents. Whether the expenditure is to serve any useful purpose or not appears to be a matter of small concern.

There are, of course, a certain number of meritorious and beneficial works for the improvement of navigation which the government properly carries on; but in order that the appropriations for these works may be passed it has come to be the custom to load up the River and Harbor Bill with appropriations for all sorts of absurd enterprises which yield no public benefit and are only planned to secure the votes of the Congressmen in whose district the money is to be spent.

Senator Burton chose a fortunate time for his campaign against this criminal waste, when the attention of the whole nation is directed toward the necessity of economy in all expenditures, public and private. His searching criticisms had such an effect that the Senate committee in charge of the River and Harbor Bill at the close of last week undertook a drastic revision of the measure, and it is reported as likely that some $20,000,000 of the appropriations carried will be eliminated before the bill is again presented to the Senate.

The Necessities of the Railways

The railways' presidents' appeal to the President of the United States last week has attracted wide public attention, as well it might in view of the figures which they presented. In the year which ended on June 30, the gross earnings of the railways of the United States decreased $44,000,000, and their expenses and taxes increased $76,000,0000. Their net income available for paying the interest on their debts, and their notes and other obligations falling due, purchase of new rolling stock and for making improvements, was therefore $120,000,000 less than in the preceding year. With railway finances at this low ebb, the war in Europe paralyzes the financial machinery of the world and makes a further enormous reduction in the volume of traffic and earnings, while shutting off any chance of reducing expenses by lowering wages because of the horizontal increase in the cost of living.

Besides all this, the railways in the territory west of Chicago have had to consent, at the request of the President of the United States, to an arbitration with their employees which will probably result in a further large increase in their expenditures. The railway financial situation is further aggravated by the fact that during the next year bonds and notes will come due, aggregating over $520,000,000.

Facing these conditions the railways appeal through the President to the public asking first of all that no further financial burdens be laid upon them; surely a reasonable request, and second, that in view of the above described situation, the public should recognize the absolute necessity that the railways shall secure additional revenue and that no obstacles should be placed by governmental agencies or other influences, in the way of measures to provide such revenue.

The reasonableness of this appeal is obvious. In fact, had not such an appeal been made by the railway presidents, it is entirely conceivable that it would have been the duty of President Wilson, himself, or of the Interstate Commerce Commission, to make such an appeal, for the railway business is a public business and not a private business, in any sense of the term. It is just as much a public business as if the railways were actually owned by the Federal Government and operated by Federal officials.

The firm or company which is engaged in manufacturing or in mining, or in buying and selling goods, may find business unprofitable, be unable to meet its debts, and be forced to suspend business entirely, as indeed thousands of private concerns doubtless will be by the strenuous times through which we are passing.

But the railway cannot suspend its operations; it is a public necessity that it should continue to run its trains and carry freight and passengers and mails. It must, in the long run, earn enough money not only to pay its employees and those who supply it with materials, but to pay the interest on its debts and a sufficient return besides to those who have invested their money in it, such that it will be able to obtain additional capital for the improvements that are all the time necessary for its efficient operation.

There can be no doubt whatever that one of the great factors in the remarkable success of Germany during the first month of the war, was the wonderful efficiency of the German railway system in the prompt transportation of the vast number of troops and their supplies. It is recognized in Europe that the railway system of a country is just as important a part of its military defense as its regiments of artillery or cavalry. And it is just as true that the efficiency of a country's railway system is a vital element in its commercial prosperity. It is not merely for the railway's welfare, but for the entire country's welfare that the railways of the United States shall be maintained in the highest state of efficiency; and this can only be done if their solvency can be preserved by provision of sufficient revenue to meet their necessities.

Letters to the Editor

The Meadi Sun Power Plant

Sir—I am glad to see the notice which you gave the Meadi sun-power plant on p. 1029 of your issue of May 7. You have been careful enough (which is more than some of the technical press have been) to point out that the engine end of the plant was in a poor state. It was terrible; the steam valves leaked, the piston probably leaked, and the slip of the irrigation pump varied from 19% to 35% according to speed and length of stroke, so it is wholly misleading and unscientific to give the overall efficiency without the careful explanation given in my paper. It would have been more "slim" on my part if I had said nothing (even unofficially as I did) about the overall efficiency, but I thought it more straightforward and scientific to state the facts and then to state some further facts which put the matter in its true light—all as a record of results really obtained. That is, I combined the actual steam production results obtained from the Meadi (Egypt) absorber with the actual steam consumption results obtained from the engine here in London, both sets of trials being made by me. This being done, it is shown that the best hour's run of August 22, 1913, would give 55.5 b.hp. for an area of 0.88 acre occupied by the absorber. This is equal to 63 b.hp. per acre, while the *average* power for the five hours' run on that day was 59.4 b.hp. per acre.

Where enterprising people have spent some $150,000 in experimental work, it is a good policy to give an unbiased account of the stage to which they have carried their work, even if it be not a completed work, for it encourages others to go on with such efforts (or abandon them on its demerits). In fact they should be given full credit for their enterprise, for where would engineering be if there were no such brave spirits?

A. S. E. Ackerman.

25 Victoria St., Westminster, London.

Instruction in Highway Engineering

Sir—Prof. Agg's outline, in your issue of Aug. 20, of collegiate work which he considers desirable in the education of highway engineers, is most excellent; and what he says in regard to ethical standards puts the truth in words which cannot be misunderstoood and should have great weight.

On the other hand, it seems to the writer, as a chemist, that Prof. Agg misunderstands the role that the laboratory plays in highway engineering when he says:

> Sufficient knowledge and experience has been gained to enable the engineer to determine by suitable tests, with a fair degree of certainty, the value of any material submitted to him.

This, in the light of my experience, is not entirely true and Prof. Agg seems to recognize this fact as he adds:

> In this work (in the laboratory), experience is of the utmost value, but if the routine tests are taught to the student, and he goes into the field of bituminous construction, he will rapidly learn to correlate the results of tests with the behavior of the materials in service.

He recognizes the fact that experience, that is to say, a service test, is the main criterion by which the value of any material in use in highway construction may be judged. A laboratory examination will provide no such evidence; but, if a material has proved itself of value by service tests, it will be able to determine the characteristics which it possesses to which its success may be attributed. Reasoning by analogy or difference, such data may be used in comparing the proved material with others which are untried and, in this way, some opinion of the value, or lack of it, of the latter may be formed.

For the highway engineer, the field which the laboratory will chiefly fill is in the control or regulation of the character of bituminous materials, the proportions in which they are used and in affording a record for future reference.

It does not seem desirable that the student should be led to believe that the merits of new and untried bitumens can be determined in the laboratory. Valuable inferences can, without doubt, be drawn; but the long-time service test is the only method of reaching a decision.

CLIFFORD RICHARDSON.

New York City, Aug. 27, 1914.

The Concrete Mixing Plant at Elephant Butte Dam

Sir—In the article on the mixing plant at Elephant Butte, published in your issue of Aug. 6, under the head of personnel, it should have been stated that the preliminary plans were based on a general layout prepared by O. L. McIntyre, Assistant Engineer and former Master Mechanic at this place. This plant layout was followed very closely throughout the design. Mr. McIntyre also prepared the preliminary specifications for the crushers, elevators and conveyors. L. C. Hill, then Supervising Engineer, suggested the use of mechanical measuring devices similar to those used before in other places and the operating mechanism followed as a natural consequence owing to the size of the measures required.

The selection of the title of the above article was unfortunate as the real object was to describe the measuring devices and operating machinery in which this plant differs mainly from other plants. The acknowledgments were made with this point in view and since the plant was mentioned as a whole it is no more than right that Mr. McIntyre be given full credit for the general designs with which the writer had no connection.

L. J. CHARLES,
Assistant Engineer, U. S. Reclamation Service.

Elephant Butte, N. M., Sept. 3, 1914.

Engineering Opportunities in South America

Sir—The letter of Cyrus T. Brady, Jr., in ENGINEERING NEWS, of Sept. 3, entitled "Opportunities for Engineers in the Argentine; A Warning," is an opportune and valuable contribution to this subject; but the writer does not agree with Mr. Brady's statements relative to the cost of living in Buenos Aires.

Compared to that in some of our smaller cities, the cost of living in Buenos Aires would be considered high, as it is practically the same as it is in New York City. Owing to the costs of transportation and import duties, imported articles are naturally expensive; but food stuffs raised in the country and commodities manufactured and produced there are just as cheap as they are in the United States. Imported luxuries such as liquors and tobacco, which are subjected to high duties the same as they are in England, are exceedingly costly, although native wines are cheap. Undoubtedly the costs of the various articles cited by Mr. Brady are given in paper currency, which is approximately equivalent to one-half the value of our own money.

Nevertheless, Mr. Brady's letter brings out forcibly many important facts to which all engineers, as well as those contemplating the extension of their business in South America, should give serious consideration.

While a resident in the Argentine Republic, the writer made a very careful study of business conditions and opportunities in that country at a time when the North Americans there constituted a very small minority.

It must be borne in mind that the basic blood of the native people is Spanish and that they retain many of the traits and customs of that Latin race, just as we retain many of those of the English. Especially is this true of their temperament. Many Argentines went to the Paris Exposition and came back imbued with French ideas and French culture and they decided to make Buenos Aires a second Paris.

It is therefore not difficult to understand why so many Argentines have since sent their sons to France to study engineering and why for a long time French engineering practice and methods of construction have been in use in the republic. The style of architecture of the modern buildings and the methods of living among the wealthier classes are decidedly French.

The Germans, with their stubborn aggressiveness and expansive policy, have secured much of the business there and owe much of their success to the fact that they have studied the needs, temperament and customs of the people and have aimed to please.

South America has in the past secured its capital in Europe to finance practically all of its large projects and for this reason the English have large interests there. European nations have placed their capital in that country with the understanding that the necessary materials would be purchased from their people.

It is also true that many articles manufactured in the United States would find a ready market in the Argentine Republic because of their superiority to similar European products, if our people would only do as the Europeans have done, namely; study conditions there and "aim to please," instead of trying to force upon a foreign people our ideas and our customs and inferior goods; as many firms have tried to do in the past.

Because of our growing power and short-sighted business policy toward them, the Argentines have naturally been suspicious of our proposals; but when once these suspicions have been dispelled, and our sincerity demonstrated by a proper handling of their business placed with us, we will find that they are an enlightened, progressive, intelligent, patriotic and responsive people.

Every engineer who goes to the Argentine Republic will find that he must compete with European talent, and practice. He must learn Spanish and be willing to adapt himself to local conditions. He will find that "patience is a virtue," that gold cannot be picked up in the streets and that only gentlemen are tolerated. When the present war is over, many foreign engineers will undoubtedly go to South America because of the chaotic conditions at home so that technical competition is apt to be greater there than it is at present.

To those who seek business in that country, it must be borne in mind that Argentina is at present suffering from excessive land speculation and unsatisfactory crops; and being unable to float loans abroad, if its business is to become healthy, the United States must go to its relief. United States capital must be invested there in the near future, as Europe will need her own capital for her reconstruction after the war or for the war itself if it continues much longer.

E. L. VERVEER.

518 West 111th St., New York City,
Sept. 5, 1914.

Annual Convention of the New England Water Works Association

The well attended thirty-third annual convention of the New England Water Works Association, held at the Copley-Plaza Hotel, Boston, Sept. 9 to 11, was a distinct advance on those of several years past. Seven sessions for business and the presentation of papers were held between Wednesday at ten and Friday at twelve. Except for a carefully planned series of doings for the ladies, all entertainment features were held in reserve until Friday afternoon and evening, when there was a boat and train excursion to Nantasket Beach, where dinner was served.

Besides two superintendents' sessions, at which a variety of practical papers were read and discussed, noteworthy features of the program were three committee reports and papers on the Salem fire, electrolysis and laying water mains so as to reduce leakage to a minimum.

The exhibit of water-works appliances made a new high-water mark. All told there were nearly fifty exhibitors, including four water-works departments. For the first time at a water-works convention, so far as we remember, a booth and chairs were provided for each exhibitor. There were four outdoor demonstrations on a working scale, as follows: Cleaning service pipes by a paper plug and a hand pump; gate-valve operation by a motor truck; calking lead joints by a pneumatic hammer driven from a portable air compressor; and cleaning water mains in a Boston street.

Committee Reports

A Standard Meter-Rate Schedule—Through Allen Hazen, Chairman, the Committee on Meter Rates presented a preliminary report, in which it submitted for discussion a standard schedule or form for meter rates. The proposed schedule deals with the basis of meter rates and not with the rates themselves, which should, of course, vary with local conditions. The schedule provides for domestic, intermediate and manufacturing rates, the first and last to determine the second, which would be half way between. Provision is also made for a service charge, made up of three parts: (1) 10% on the average installation cost of the meter and service pipe, or say $2.50 where the city puts in the service and sets a ⅝-in. meter, or $1 where the meter only is supplied by the city; (2) $1 per annum for meter reading, billing, etc.; (3) $2 per annum for water which passes the meter without being recorded. Where local objections to a service charge are sufficiently strong, the committee suggests that the service charge, as outlined, be divided by 60 and the quotient to the nearest cent added to the domestic rate on the first 60,000 gal., thus making a loaded or maximum rate.

The proposed domestic rate would apply to water consumed up to 300,000 gal. per annum; the intermediate to the consumption between 300,000 and 3,000,000 gal., and the manufacturing to all in excess of 3,000,000 gal.

The report included a summary table of actual meter rates charged by a considerable number of cities, with comparative figures on the rate basis recommended by the committee; also a number of diagrams.

After a brief and generally favorable discussion of this report it was voted to take up the subject at an early monthly meeting of the Association. Meanwhile printed copies of the report will be sent to members, with an invitation to submit written discussions.

Statistics of Water-Purification Plants—Through Geo. C. Whipple, Chairman, the Committee on Statistics of Water-Purification Plants submitted a preliminary report and expressed the hope of presenting a final report next January. Its studies have been divided as follows: (1) descriptive data; (2) analyses; (3) engineering; (4) financial, and (5) vital statistics. Tentative standard forms for general descriptions of water purification plants and for reporting water analyses in tabular form were presented. Seven tables of analyses are proposed. Three of these tables show for raw water its (1) chemical and microscopical character; (2) its turbidity and color; (3) total bacteria. The last four tables show for the water delivered to the mains its (4) chemical character; (5) turbidity and color; (6) total bacteria; (7) B. coli. All these data are shown as averages for each month and for the year, with number of test days, and with classified variations in turbidity, color and bacteria. For some of the most significant determinations both mean and median results are given. Two printed pages are well utilized to set forth why "percentage removal of bacteria" is unsatisfactory and has been thrown overboard.

Three "grades of control" of filter plants are proposed: (1) analyses of filtered water at daily or more frequent intervals, with the collection of engineering and other operating data by one or more attendants, constantly employed; (2) weekly or monthly analyses by a trained analyst, with simple daily tests by an attendant constantly on duty; (3) irregular and infrequent analyses, with no daily tests by the attendant.

There was no discussion of this report at the convention, but written discussion is invited. The report will be mailed to the members of the Association and will be brought up for oral discussion in the early winter.

Low Stream Yields—A vast amount of labor carried on for several pears past was summarized in a report of 70 printed pages presented by F. P. Stearns, Chairman of the Committee on Low Water Yields of Catchment Areas in New England. The committee was appointed early in 1911 to gather data on the low stream flows of 1908-09-10, but as 1911 proved to be even drier and 1912 and 1913 nearly as dry the studies were extended over the later years as well. They were also extended geographically to cover the Croton River, Esopus, Rondout and Schoharie Creeks (New York City water-supply). Thus altogether 22 drainage areas in New England and eastern New York were studied. The report is really a monograph on the subject indicated. Besides rainfall and runoff records for the 22 drainage areas the general subject of stream yields and storage capacities is discussed. Tables of safe yields for the various streams are given. Numerous diagrams are included. The records and deductions are all the more significant because the recent dry period was drier (in New England) than the very dry years, 1879 to 1884, the driest on record so far as runoff is concerned, though rainfall records indicate still drier years before 1850.

In discussing the paper, Allen Hazen referred to the application of the law of probabilities to runoff and storage problems, contained in a paper which he presented earlier this year before the American Society of

Civil Engineers. Mr. Hazen agreed with Mr. Stearns' opinion that probably still drier years will occur as the records are extended, and that the new low records will again be outdone. Past practice has been to assume that dry periods will be repeated. The probabilities are that 19 out of 20 years will follow the past and that one year will be drier still. Mr. Stearns then expressed himself as quite in agreement with these remarks by Mr. Hazen and added that while lower rainfalls than those recorded must be expected the water consumption of a given city is ever increasing.

H. K. Barrows, commenting on the use by the committee of the FitzGerald evaporation studies, remarked that while these studies were excellent when made yet the few similar studies made elsewhere have given different results. He suggested that since evaporation tests are easily made they might well be carried out in various localities governed by different conditions.

Standard Specifications for Cast-Iron Pipe—In behalf of this committee, Frank A. McInnes, Chairman of the committee and President of the Association, stated that several meetings with manufacturers have been held but the committee is not yet ready to submit its final report [which report, it is hoped by many, will lead to a joint standard specification on the part of the New England American Water Works Associations.—Ed.]

General Papers

Of 14 papers on the program, 12 were presented by the authors in person, and two, which had been printed for circulation at the meeting, were read by title, the authors not being present.

Allowable Leakage from Water Mains—E. G. Bradbury, of Columbus, Ohio, presented some remarkable records of low leakage from new water mains laid under rigid specifications and tested in the open trench before covering at Akron, Ohio. The leakage shown by 86 tests on a total of 16.76 miles of 4- to 30-in. cast-iron mains laid by contract averaged 83.4 gal. daily per inch-mile and on 8.9 miles of 6- to 10-in. pipe (38 tests) 61.7 gal. daily per inch-mile (leakage per mile for each in. diameter of pipe).

Dexter Brackett did not think it practicable to keep trenches open for testing pipe in thickly populated districts. Mr. Bradbury remarked that the length of open trench can be lessened by using more gates and that this will pay where it is necessary. His paper showed that the water saved by tight mains will pay for considerable extra capital outlay. W. C. Hawley said that in open-trench work he had found leadite very useful, because when jointing with that material short lengths of pipe can be tested readily. A. D. Flinn stated that in some special cases lead wool had been used advantageously.

Lessons from the Salem Fire—A unique study of the water-supply of Salem, Mass., during the recent conflagration was contributed by Frank A. McInnes and Clarence Goldsmith, of Boston. Besides summarizing actual fire-engine operations, the authors presented the main results of water-consumption experiments made after the fire, with outlet conditions as nearly as possible like those during the fire. The chief lesson drawn by the authors was that large connections between street mains and fire-sprinkler systems of protected buildings cause a great risk since, as in the Salem fire, falling walls may break these large services, causing so large a loss of water as to cripple the water-supply and fire service.

In remarks supplementing the paper Mr. Goldsmith stated that Boston limits sprinkler connections to a diameter of 4 in., but permits a number of connections of that size, generally 50 ft. apart.

A number of representatives of fire insurance companies made a stand for larger connections than 4 in. One of these speakers urged that the primary cause of the Salem conflagration was an undermanned fire department —27 men, some of whom were off duty. Had not the fire been allowed to get under way the breaks in sprinkler connections which bled the water-supply would not have occurred. Salem also needed much better building construction than it had.

Notwithstanding all that was said by others, the authors of the paper stuck to their opinion that the Salem conflagration was due to breaks in large sprinkler mains and that 4-in. connections would have been sufficient to supply the sprinklers at Salem, and that connections of that size, supplemented by fire engines coupled up through an outside siamese, would suffice and afford greater safety than a larger connection. This opinion seemed to be concurred in by all present except the insurance representatives.

Electrolysis—A review of the electrolysis studies made during the past few years by the United States Bureau of Standards was presented by E. B. Rosa, Chief Physicist of the Bureau. Many of the results have already been made available through various Technological Papers, and further papers are to be published.

So far as tests of pipe coatings have gone, these are of little service in presenting electrolysis. Insulating joints are more useful, but of limited value. Track drainage or pipe drainage must be the chief resort (assuming that a complete return-wire system is not used). There should be more coöperation in the prevention of electrolysis. In any event the burden of protecting underground structures from electrolysis should be borne by the street-railway companies.

Metering an Old City—How Boston is being converted from a practically unmetered to a metered city under mandatory state legislation passed in 1907, but little heeded until 1909, was told by James A. McMurry, Engineer-in-Charge Income Branch, Boston Water-Works. This legislation required that all new services be metered and that old services be metered at the rate of 5% a year. Some 5000 to 6000 meters a year are being set. At first this work was scattered over the city, but soon the practice of metering a whole district at a time was established. This not only saves installation costs but also affords an opportunity to make valuable studies of results obtained. Some 36,000 meters have been set, increasing the percentage of services metered from 6% in 1908 to 41% at the close of 1913. The effect on the consumption of the whole city can be seen and there has, of course, been a much more notable reduction in per capita consumption in the districts fully metered.

Other General Papers—Papers on "The Construction of Dams," by A. E. Walden, of Baltimore, Md., and on the "Miraflores Water Purification Plant," by Geo. M. Wells, of the Canal Zone, were read by title in the absence of the authors.

Papers at the Superintendents' Sessions

Eight papers were read at the two superintendents' sessions. Most of these brought out, as was intended, a goodly discussion.

HOUSE-BOILER TROUBLES—F. F. Forbes, Brookline, Mass., told how changes from attic tanks to direct supplies for hot-water boilers has added to his worries. There were two boiler explosions in Brookline during the last year. The remedy suggested was expansion tanks. This suggestion seemed to meet with general approval by those who listened to the paper but one speaker urged that in addition to using expansion tanks hot-water plumbing should be inspected to insure good materials and workmanship.

MACHINE CALKING OF LEAD JOINTS—At Waltham, Mass., as told by Daniel T. Higgins, a truck-mounted air compressor and pneumatic hammer is reducing the time and cost of calking water mains. The outfit cost only a few hundred dollars. It has also been fitted with an air drill, for use in rock-trench excavation.

THE CARE OF GATES AND HYDRANTS—Patrick Gear described how this is done at Holyoke, Mass. Each fire hydrant has a card record and is periodically inspected. In winter a lead is used to sound the hydrant for ice. If ice is found, it is thawed out and if water is found it is pumped out. Salt is used to prevent freezing.

As to gates, Mr. Gear had more to say about their design and material than upon their maintenance. He recommended a liberal use of brass parts where the members are specially liable to wear or corrosion, and that provision be made for cleaning mud from small as well as from large gates.

In the discussion of this paper one member told of the use of a pint to a quart of wood alcohol per hydrant to keep hydrants from freezing and another told of using crude glycerin.

WATER USES DIFFICULT TO CONTROL—These, as outlined by Wm. F. Sullivan, Nashua, N. H., include water for building purposes, street and sewer flushing. The remedy is universal metering or at least metering all who practice abuses. Several speakers told of tricks to beat the water meter. The only way to prevent these is through sealing of the meter and its connections to prevent tampering.

THE AUTOMOBILE AS AN EFFICIENCY AGENT IN WATER-WORKS MANAGEMENT—The uses and costs of eight motor vehicles at Worcester, Mass., were set forth by Geo. W. Batchelder of that city. The first automobile was introduced in 1909. Records have been kept for each car. The yearly operating costs range from between $200 and $300 for a Ford car to $1200 to $1300 for general-service cars and a large truck. The latter has been used extensively for hauling pipe and has been highly advantageous for heavy work, long hauls and emergencies.

PUBLIC WATERING STATIONS—Frank E. Merrill, of Somerville, Mass., told how he had coöperated with the State Department of Animal Industry in efforts to reduce glanders by getting rid of common open horse-watering troughs. In their place, provision is made for filling pails carried by teamsters. A 12-in. cast-iron pipe is set in the ground at the curb line, bell up and 29 in. above the sidewalk. A 2-in. riser-service connection is topped with a cross, equipped with two self-closing faucets and a hose connection for filling pails and with a bubbling fountain for human beings. Near the sidewalk a bowl for dogs and birds is placed. The outfit costs about $20 for material and $20 more for labor. Besides the primary object of helping reduce glanders, it is believed that these watering stations will save a considerable amount of water. The speaker exhibited one of the appliances, and referred also to another exhibit at the convention, showing how Boston has converted old common troughs to pail-filling stations.

Mr. Merrill introduced the State Commissioner of Animal Industry and the President of the Massachusetts Society for the Prevention of Cruelty to Animals, each of whom addressed the convention. The former was heartily in favor of, in fact largely responsible for, the widespread abolition of the common horse trough in the Boston Metropolitan District and cited both statistics and leading veterinarians and other authorities in support of his views. The latter opposed the innovation on the ground that lazy drivers would not take the trouble to get off their wagons and fill pails, and that, as a consequence, many horses would have to go for long periods without water, and would then injure themselves by overdrinking. He also cited figures which he thought proved that horse troughs have comparatively little to do with the spread of glanders. In conclusion he sought to clinch his claims by asserting that there are all sorts of germs everywhere—which no one denied.

LOW WATER CONSUMPTION IN MILTON, MASS.—D. A. Hefferman reported that Milton uses only 39 gal. of water per capita per day because (1) it has the universal meter system, extending to all uses of water except through fire hydrants; (2) because it insists on good construction; and (3) because of thorough inspection. The water department lays all service pipe to a point inside the building wall and allows no one except firemen to use fire hydrants.

USE OF THE MAGNETIC DIPPING NEEDLE IN LOCATING SERVICES AND GATE BOXES—Edward D. Eldredge, of Onset, Mass., stated that in small places it is often necessary to find services after street grades have been changed and where no records have been made. The dipping needle will aid in this task, even through 6 or 7 in. of concrete sidewalk. L. M. Bancroft, of Reading, Mass., said he had located a service box by this means beneath 13 in. of concrete, and J. M. Diven, of Troy, N. Y., went Mr. Bancroft 1 in. better.

Annual Convention of the Roadmasters and Maintenance-of-Way Association

The 32nd annual convention was held at the Auditorium Hotel, Chicago, Sept. 8 to 11, with the President, T. F. Donahoe (B. & O. R.R.) in the chair. The attendance was large, and in connection with the meeting there was an exhibit of track materials, tools and appliances arranged in a hall adjacent to the meeting room. An unusual feature which is peculiar to the meetings of this association is that very few papers or reports are presented, but that those are discussed at such length that they more than suffice to occupy the time of the convention. There were nine sessions, eight of which were devoted mainly to business, and although only five reports were presented, some parts were accepted as information owing to lack of time for full discussion.

POWER-OPERATED TRACK TOOLS AND APPLIANCES—This report, presented by J. W. Dahl (N. Y. Central R.R.), opened with an explanation of the increasing use of machinery in track work, owing to its economy as compared with hand labor and to the increased weight and

size of many parts used in track construction. Motor cars in place of hand cars save time and energy of the track men, and enable the same number of men in a gang to do more work or a smaller number of men to do the same amount of work as when equipped with hand cars. Rail-handling machines for loading rails on cars and distributing new rails from cars not only do the work more expeditiously but eliminate the rough handling which may result in damage or fracture of the rails. For rail renewals, there are machines which, with three to six men, do the work otherwise requiring a large gang of men to handle long and heavy rails.

Other uses of machinery are in such heavy work as ditching, the distribution of ballast, and the spreading of filling material; and also in such light work as drilling and cutting rails, boring and dressing ties, driving screw spikes, tamping ballast, etc.

RAIL RENEWALS—This report was presented by A. M. Clough (N. Y. Central R.R.), and was discussed at great length in regard to the various phases of the work. There was considerable discussion as to whether or not ties should be respaced when new rails are laid, and the general opinion was that this is not necessary, while eliminating the work greatly reduces the time consumed. Several railways now leave the ties alone, simply dressing them at the rail seat where necessary, and adjusting them to give proper support at the joints. The report submitted the organization for a rail-renewal force, but some members were inclined to object to this, since no two roads would have the same conditions or use exactly the same force.

ORGANIZATION OF LABOR AND MATERIAL FOR TRACK MAINTENANCE—This report was presented by P. J. McAndrews (Chicago & Northwestern Ry.). It showed the great amount of money expended under the direction of the track department (averaging $10,000 per month per roadmaster), and advocated a system of organization in which the work of all the roadmasters of any one division would be under the supervision of some official who would direct the work of the division as a whole. This would avoid the trouble and expense due to operating separate work trains, rail-renewal gangs, extra gangs, etc., on each roadmaster's district. The report recommended the maximum length of line for the roadmasters or supervisors as follows: 50 miles of double-track, 100 miles of single track with heavy traffic or 125 miles in easy country with light traffic.

Another important recommendation was that track forces should be maintained permanently, throughout the year. At present, every railway cuts its force to a minimum in winter and increases it in the spring, when the supply of efficient men does not equal the sudden demand. This results in loss of time and money due to the continual employment of new and inexperienced men. Much of the work can be done as well in winter as in summer, and the work as a whole would be done better and at lower cost if spread over the year instead of concentrated in a few months, as under the present system. There was general agreement with the suggested system, but it did not appear that any roads have yet introduced it, the economies of track labor not being comprehended as a rule by railway officers.

TRACK ACCESSORIES—This report, which was presented by M. Donahoe (Chicago & Alton Ry.), dealt with a variety of matters, and the first of these were discussed in such detail that the remainder of the report was accepted as information, without discussion. In regard to rail joints, the committee recommended 24-in. angle bars, with four bolts, supplemented by a base or bridge plate where traffic is heavy. For frog guard-rails an 8-ft. length was recommended, but this was struck out, as there was a general opinion that longer rails are preferable, and that it is not desirable to specify the length.

There was considerable discussion as to whether bolts or clamps are the better for securing the guard rail to the track rail, and as to the use of tie-plates and rail braces at guard rails. Cast manganese guard rails were mentioned, but the members present had little experience with these. Other matters covered by the report were switches, frogs, switchstands, tie-plates, rail anchors or anti-creepers, screw spikes and drive spikes, track bolts of nickel-chrome steel, and the narrow-head "frictionless" rail for curves (ENGINEERING NEWS, July 2, 1914).

As to this last, only one member had experience, and he spoke of tests showing that with a train on a heavy grade the speed increased on curves having this rail on the inside, while it decreased on curves laid with ordinary rails. Some members spoke of getting the same result by shifting worn rails from the outer to the inner side of the curve, but it was pointed out that in such case the weight of the wheel comes on the overhanging side of the rail head and not directly over the web, as in the special narrow-head rail. Consequently this shifting of worn rails or curves was hardly desirable for track with heavy traffic and high speeds.

CLEARING AND POLICING RIGHT-OF-WAY—This report was read by J. P. Corcoran (Chicago & Alton Ry.). It dealt with such work as the cutting of weeds and grass, removing old rails and ties, the handling of scrap, maintenance of ditches and fences, and the clearing of yards and station grounds. Trackwalking and bridge inspection were included also. The report recommended the old practice of requiring the trackwalker to do all kinds of miscellaneous work during his trip, but this was objected to in the discussion. It is better for him to be simply an inspector, doing only such work as is essential to the safety of the track. The miscellaneous work of driving loose spikes, repairing fences, etc., can be done to better advantage in periodical trips of the entire section gang.

OFFICERS

Officers for 1914-15 were elected as follows: President, P. J. McAndrews, C. & N. Ry., Belle Plaine, Ia.; Secretary, L. C. Ryan, C. & N. W. Ry., Sterling, Ill. The next meeting will be held at Chicago in September, 1915.

The Annual Convention of the National Paving Brick Manufacturers Association

The chief features of interest to engineers in connection with the 11th annual convention of the National Paving Brick Manufacturers Association, held in Buffalo, N. Y., Sept. 9-11, were the discussion of inspection of paving brick and the excursions to various parts of Buffalo and the surrounding country to visit and inspect brick pavements in all stages of age and construction.

As to the inspection of brick, there appeared to be much dissatisfaction with present practice. The specifications

are constantly becoming more severe and the manner of testing the brick after they have been distributed on the road to be paved, and there condemned, often works great hardships on both the paving contractor and the brick manufacturer.

Nevertheless there was no unanimous demand or, apparently desire on the part of the brick manufacturers for universal factory inspection. The objections seemed to be a horror of having a corps of inspectors about the plant, as might be necessary if each buyer had his own individual inspector, and a frankly expressed fear that there would be subsequent difficulty in disposing of brick condemned by anyone of the inspectors—and it is necessary to dispose of the poorer as well as the best brick in order to run a brick plant at a profit.

Coupled to these objections were, of course, the usual ones that competent inspectors were rare, and differences of opinion as to what constituted good qualities in paving brick. To remedy the former one member proposed the training of engineering graduates at the plants by a few months' course in practical brick making. In regard to tests of paving brick it was generally conceded that the manufacturer is not safe from having his brick rejected unless he makes it test 2% better than that specified by the buyer, in order to provide for uncontrollable variations in the rattler test.

O. N. Townsend, of the T. B. Townsend Brick & Construction Co., Zanesville, Ohio, spoke strongly in favor of factory inspection, which had been tried on a large scale at his plant. He said it was the only means by which he could get a contractor to undertake the pavement of several miles of the Lincoln Highway under the Ohio State Highway Department specifications. So successful and satisfactory had factory inspection proved that he stated his plant would hereafter insist on it for all contracts; if necessary, he would pay the inspector. C. P. Mayer of the C. P. Mayer Brick Co., Bridgeville, Penn., spoke in much the same strain.

The only result of this discussion was an unofficial resolution adopted by the manufacturers at an informal conference with the paving-brick committee of the American Society of Municipal Improvements (E. H. Christ, Grand Rapids, Mich., Chairman) providing: that it was the unanimous sense of the meeting that the paving-brick committee of the American Society of Municipal Improvements recommend to its society factory inspection of brick for abrasion loss.

The following officers were elected: President, Charles J. Deckman, of the Deckman-Duty Brick Co., Cleveland, Ohio, who has been President since 1911; Vice-President, J. W. Robb, of the Clinton Paving Brick Co., Clinton, Ind.; Treasurer, C. C. Barr, of the Barr Clay Co., Streator, Ill.; Secretary, Will P. Blair, Cleveland, Ohio.

Notes on the inspection trip of the association and its guests will appear in a later issue.

NEWS NOTES

A Water Tank Fell at the Harbauer tomato pulp factory at Curtice, Ohio, on Sept. 4, releasing about 6000 gal. of water.

A 6-in. Water Main Burst in Philadelphia, Penn., on Sept. 10, flooding cellars and damaging the pavement in the vicinity of Marlborough St. and Gerard Ave.

A Freight Train Went Through a Flood-Weakened Bridge on the Missouri Pacific Ry. near Dover, Mo., at 11:40 p.m., Sept. 7. Two men who are missing are thought to have been killed.

A Wood Bridge Collapsed under the weight of a load of gravel, at Gloversville, N. Y., on Aug. 31, dropping team, wagon, gravel and two men into Cayadutta Creek. Local reports state that the structure was weakened by high water resulting from heavy rains. The bridge was built four years ago. It failed when the load was midway on the structure.

A Train Went Through a Wood Bridge on the Missouri, Kansas & Texas Ry. at Boggy Creek bridge five miles south of Taylor, Tex., at 5 p.m. Sept. 1. The engine passed over the bridge, and, as far as can be learned from local reports, the oil tender left the track near the south end of the bridge. The baggage, combination, and chair cars went through the bridge, which was a 16-bent structure.

Floods in Kansas City, Mo., on Sept. 7, damaged the Country Club district, the South Side along Bush Creek, the East and West Bottoms, Sheffield and other districts. Conditions were most severe in the southwestern part of the city and in Rosedale, a suburb, where the water reached a maximum depth of 25 ft. A 10-hr. rain, with a precipitation of 6.94 in., caused the floods. In addition to many flooded buildings, two railway bridges across Turkey Creek were carried out, and three persons were killed.

The Alaska Government Railway Surveys are reported to be making good progress. The parties in the field number about 140. Work will be suspended during the winter, but it is expected that actual construction can begin as soon as spring opens.

The Chicago Water-Works Intake Tunnel, which is to extend under the lake from Wilson Ave., is to be built by day labor. All bids were rejected and the City Council has granted authority to the Department of Public Works to carry on the work. It will be under the direction of John Ericson, City Engineer.

A High Discount Rate for Payment of Metered-Water Bills in Chicago will go into effect on Nov. 1, as the result of a city ordinance passed on July 2. The discount will be 25% on all meter bills paid within 30 days of the date of the bill. The present discount rate is 15%. The meter rate is 62½c. per 1000 cu.ft. or 8⅓c. per 1000 gal.

American Trade Opportunities in South America are to be investigated by the American Express Co. Two representatives of the company, Messrs. James Paine and A. B. Howard, will sail from New York, Oct. 1, to visit the principal cities in Brazil, Uruguay, Argentine, Chili and Peru to investigate methods by which United States trade with South America can be developed.

Beginning of an Industrial-Education System is being attempted in the New York Public Schools. At present two schools in Manhattan Borough, two in Brooklyn and one in Queens are being operated on a "coöperative plan," which seems for the moment more aimed at more intensive use of plant than for definite industrial education. By dividing the school into two groups, or by organizing a duplicate school to use the same plant, it is possible to have one group in the classroom while the other is in the shops, library or playground.

The Last Section of the Harlem River Tunnel of the Lexington Ave. subway, in New York City, was sunk Sept. 16, 1914. This is the fifth of similar sections which have been successfully sunk to form the subway crossing under the river. Each section consists of a steel box or caisson 220 ft. (in one case 199 ft.) long, and wide enough to provide room for a four-way tunnel of standard section. This box is floated out above its final location and sunk into a prepared position by filling with water. It is then filled with concrete and joined to the next adjoining section already in place. The work is being done by the Arthur McMullen & Hoff Co.

Fewer Forest Fires on Cape Cod have resulted from the carrying out of the clearance plans of the New York, New Haven & Hartford R.R., outlined by Edward G. Riggs, Executive Assistant, last fall. The acreage cleared will be kept clear by a section gang, giving a permanent character to the work. From May to August, 1914, according to Mr. Riggs, only 11 fires were attributable to sparks from locomotives, and the burned territory amounted to not more than 6¼ acres. In the same period last year, there were 155 fires from this source, which burned over an area estimated at about 2000 acres; in 1912, there were 112 such fires, burning over about 480 acres. In 1911, there were 59 such fires on 477 acres. This year, half of the comparatively small area burned was woodland and half grassland.

Manufacturers of Motor Vehicles expect that the European war may give a new stimulus to the demand for such vehicles, especially those for commercial purposes which now form a very respectable proportion of the automobile busi

ness. While the purchase of cars for pleasure and as a luxury will doubtless be seriously restricted for some time, the great casualties among horses in the war seem certain to cause a great shortage and still higher prices for horses not only in Europe, but in America. The high prices of grain and forage and the great demand for cattle, which seem certain to prevail for a good while to come, will also tend to discourage the raising of horses, and will make their keeping more expensive. All these things tend to favor the substitution of motor-driven vehicles for horses wherever the conditions permit.

The Proposed Standard Specifications for Steam-Boiler Construction framed by a committee of the American Society of Mechanical Engineers were considered at a public hearing at the Engineering Societies Building in New York City on Wednesday, Sept. 15. The hearing was attended by about 150 engineers representing the principal steam-boiler manufacturers and representatives of state boiler-inspection departments and also various societies interested in steam-boiler construction, inspection and use. John A. Stevens, of Boston, chairman of the committee, presided and opened the meeting with a statement of the causes which had led to the formation of a committee by the Society to frame standard specifications. Addresses were made by E. H. Wells, President of the Babcock & Wilcox Co., and Thomas E. Durbin, of the Erie City Iron Works, which emphasized the absolute necessity to the boiler-manufacturing interests of standard specifications suitable for adoption by all the states of the Union. After further general remarks, the meeting took up the proposed specifications for discussion in detail.

Suggestion for a Cantilever Bridge Across San Francisco Bay is made by C. E. Fowler in "Western Engineering," issue of Sept. 1914, on the basis of general designs which he has worked out. The plan is for a crossing between Telegraph Hill (San Francisco) and Oakland via Goat Island. The span from Telegraph Hill to Goat Island includes three cantilever spans of 2000 ft. with tower spans of 250 ft., and at either end a land span (cantilever arm and terminal suspended span) of 1350 ft. east of Goat Island the bridge would consist of an 880-ft. cantilever span, a mile and a half of viaduht, and about two miles of fill. In general design the structure is closely similar to the Forth Bridge, except that the suspended span is much longer, being 700 ft. The constructive details also show a leaning toward the Forth type. In particular the compression members are double-walled tubes, but instead of being circular as in the Forth bridge they are octagonal, with metal cross-sections up to 3600 sq.in. The cost of the bridge in its entirety is estimated at $75,000,000, of which the three-span cantilever structure between San Francisco and Goat Island is figured at $49,000,000.

A Reinforced-Concrete Building Collapse at La Ceiba, Honduras, on Aug. 19, was reported in a very generally circulated press dispatch as follows:

Washington, Aug. 20—Forty British and American workmen were killed today in the collapse of the new concrete customs house at Ceiba, Honduras, according to a dispatch to the State Department.

D. J. Klodt, formerly of San Antonio, Tex., was the only name given of those killed. Many workmen were burned under the ruins and smothered. A fire enveloped the structure after its collapse.

We are informed by H. J. Hill, Chief Engineer Vaccaro Bros. & Co., of La Ceiba, that the cabled report was greatly exaggerated. He states that the second floor of the reinforced-concrete customs house under construction at La Ceiba failed on Aug. 19, and in the collapse four workmen were killed outright, one fatally injured and three more slightly injured. The apparent cause of the collapse was a lean concrete, which failed immediately upon the removal of the falsework. As near as could be determined by Mr. Hill, who had nothing to do with the building, the proportions of the concrete was about one part cement to eight parts sand, with no gravel or broken stone in the mix. The building was designed for the contractor by B. G. Klodt, who was killed in the collapse. There was no inspection other than that of the builder.

Temporary Closing of Drawbridges to accommodate commuting traffic near large cities has been repeatedly urged by commuters, but the historical and apparently inalienable rights of water navigation over land traffic in practically every instance has prevented such closing. Commuters who have suffered from this refusal of the law to recognize modern conditions will appreciate the recent order of the Secretary of War approving amended regulations governing the opening of the draws of the Highway Bridge and the Pennsylvania R.R. bridge over the Potomac River at Washington, D. C., whereby both of those bridges are closed against water traffic between 8:20 and 8:50 a.m. daily, except to vessels employed or controlled by the Government.

It was suggested by the railway interests that the draws be closed from 7 to 9:30 a.m., and from 4 until 6 p.m. daily because of reported frequent delays to land traffic during these hours. Navigation interests, however, made a stout protest against such a long closed period and the War Department permitted only the morning closing. In recommending the closing General B. C. Kingman, Chief of Engineers, said:

After due consideration of the evidence adduced at the public hearing and the papers in the case, it is thought that the closed periods advocated by those interested in land traffic would result in detriment to river traffic out of all proportion to the benefit to be derived by traffic over the bridges. On the other hand, a closed period of not longer than 30 min. during the morning rush hours appears to be necessary to accord some measure of relief to traffic over the bridges and will not in the opinion of this office impose an unreasonable hardship on water-borne traffic.

PERSONALS

Mr. Chas. W. Gates, Highway Commissioner of Vermont, has been nominated as the candidate for Governor on the Republican ticket.

Mr. S. S. Senter, formerly Engineer of Construction of the Wheeling & Lake Erie R.R., has been appointed Superintendent of Bridges and Buildings, with headquarters at Brewster, Ohio. The office of Engineer of Construction has been abolished.

Mr. Henry A. Woods, M. Can. Soc. C. E., Assistant Chief Engineer of the Grand Trunk Pacific Ry., at Winnipeg, Man., has been appointed Chief Engineer to succeed Mr. B. B. Kelliher, M. Can. Soc. C. E., resigned, as noted in our personal columns of last week.

Mr. Frank W. Skinner, M. Am. Soc. C. E., has resigned as Associate Editor of the "Engineering Record" and will devote his whole time to private practice, specializing in methods and plant for the execution of civil engineering construction, with office at 41 Sherman Ave., Tompkinsville, N. Y.

Mr. Frank F. Fowle, M. Am. Inst. E. E., Consulting Electrical Engineer, has closed his New York City office at 68 Maiden Lane, and has moved to Chicago, Ill., where he has been appointed one of the receivers of the Central Union Telephone Co., with headquarters at 212 West Washington St.

Messrs. Vrooman & Perry, Consulting Engineers of Gloversville and Amsterdam, N. Y., announce the dissolution of the partnership. Mr. Morrell Vrooman, Assoc. M. Am. Soc. C. E., will maintain offices at Gloversville and Amsterdam, and Mr. Charles T. Perry, Assoc. M. Am. Soc. C. E., will open an office at 102 Hudson Ave., Albany, N. Y.

Mr. W. E. Duckering, recently with the Oregon Short Line Ry., at Pocatello, Idaho, has been appointed Instructor in civil engineering at the University of Washington, Seattle, Wash. He takes the place of Prof. C. W. Harris, who has been granted leave of absence in order to devote his time and attention to the development of some small water powers in the Cascade Mountains.

Messrs. J. Wharton Bartholow and George H. Willits have formed the Bartholow-Willits Engineering Co., of Galveston, Tex., and will engage in the general practice of civil engineering, with headquarters in the Reymershoffer Building. They will specialize in sewage disposal and public utility valuation. Mr. J. C. Nagle, M. Am. Soc. C. E., Chairman of the Board of Water Engineers, State of Texas, is Consulting Engineer of the new firm.

Mr. Frederick C. Noble, M. Am. Soc. C. E., Division Engineer, Public Service Commission, First District, New York, who has been in charge of the East River tunnel division of the new subways in New York City, has resigned. He has been in the city subway work since the first subways were built in 1900. It is understood that he has left the Public Service Commission to devote his whole time to private practice, much unfinished work having been left by his late father, Alfred Noble, Past-President of the American Society of Civil Engineers.

Mr. W. S. Moseley has been promoted to be Mechanical Engineer of the Carolina, Clinchfield & Ohio Ry., with headquarters at Erwin, Tenn. Mr. Moseley was educated at the Virginia Polytechnic Institute. He began railway work as a messenger boy in the auditor's office of the Norfolk & Western Ry. in 1894. From 1902 to 1909 he was a draftsman in the Mechanical Engineer's office, with the exception of two years when he was an instructor at the institute. He was appointed a draftsman with the Carolina, Clinchfield & Ohio Ry. in 1909.

Mr. William F. Allison, M. Am. Soc. C. E., formerly Professor of hydraulics and sanitary engineering at the University of Oregon, has been appointed Professor of municipal and highway engineering at the University of Washington, Seattle, Wash., succeeding Prof. E. J. McCaustland, M. Am. Soc. C. E., whose resignation was noted in these columns Aug. 20, 1914. Prof. Allison is a graduate of South Dakota State College, Purdue University and Cornell University. He served as an Engineer Officer in the U. S. Volunteer Army in the Philippine Islands during the Spanish-American War. He was formerly a member of the faculty of the Colorado School of Mines and City Engineer of Golden, Colo.

Prof. Grandville R. Jones, Assoc. M. Am. Soc. C. E., Professor of sanitary engineering at the University of Kansas and Engineer of the Kansas State Board of Health, has resigned to accept an appointment as Professor of hydraulics and sanitary and water-supply engineering at the new engineering school of the Johns Hopkins University, Baltimore, Md. Prof. Jones graduated from Ohio State University in 1904, and from the Massachusetts Institute of Technology in 1907. For two summers he was with the Pennsylvania R.R. in Chicago, Ill., and for a year was with the Mt. Vernon Bridge Co., Mount Vernon, Ohio. For five years following his graduation from the Massachusetts Institute of Technology in 1907 he was employed at the water filtration plant at Washington, D. C.; during the last three years he was Assistant Superintendent. Since 1912 he has been at the University of Kansas.

OBITUARY

Parker Spofford, former Railroad Commissioner of Maine and a civil engineer, died Sept. 7 at his home in Bucksport, Maine. He was born in 1842.

Viner J. Hedden, President and Treasurer of the V. J. Hedden & Sons Co., builders, New York City, died Sept. 11, at his home in East Orange, N. J., aged 88 years.

Wilson Brown, a retired civil engineer and a former member of the engineering staff of the Pennsylvania R.R., died Sept. 11, at his home in Setauket, L. I., aged 63 years.

Richard F. Stevens, a retired civil engineer, died at his home in South Orange, N. J., Sept. 2. He was born in 1832 and was a nephew of Edward A. and Robert Stevens, the founders of Stevens Institute of Technology.

Nelson M. Markley, for many years Supervisor of Bridges and Buildings of the Peoria & Eastern division of the Cleveland, Cincinnati, Chicago & St. Louis Ry., Arcanum, Ohio, died Sept. 5. He was 67 years old and had been in the railway service for 42 years.

Luther S. Anderson, former General Manager and recently Treasurer of the Granite Ry., which was built and operated to develop the granite quarries of Quincy, Mass. He was born in Massachusetts in 1853 and graduated from Harvard University in 1882. He was at various times Assistant Treasurer, Secretary and General Purchasing Agent of the Union Pacific Ry.

Paul A. S. Guerber, a prominent mechanical engineer and founder of the Guerber Engineering Co., Allentown, Penn., died at his home in that city, Sept. 10, from appendicitis. He was born in Brooklyn, N. Y., 53 years ago. He was a graduate of Stevens Institute of Technology and for several years was employed by the Jackson Manufacturing Co., Harrisburg, Penn.

William H. Pratt, General Superintendent of the North Works of the Illinois Steel Co., at Chicago, died on Sept. 6. He was born at Norwich, Vt., Oct. 23, 1852. His earlier experience was in railway engineering. In 1880-1881, he was Assistant Engineer of the Toledo, Chicago & St. Louis Ry.; in 1882, Principal Assistant Engineer of the Chicago & Indianapolis Air Line Ry. (now the Chicago, Indianapolis & Louisville Ry.), and in 1883, Chief Engineer of Construction on the first named railway. He then turned to bridge engineering, and in 1884-87 was Assistant Superintendent of the Morse Bridge Co.; in 1887-89, Engineer of Construction of the Edge Moor Bridge Works, and in 1889-95 was General Manager of the Mt. Vernon Bridge Co. He then went into private practice, and in 1895-98 was in business as an engineer and contractor. In 1899, he went to Chicago to take charge of the Universal Construction Co., a bridge-building concern, which afterwards became the North Works of the Illinois Steel Co., and he remained in charge of this plant until the time of his death. He became a member of the Western Society of Engineers in 1899.

ENGINEERING SOCIETIES

COMING MEETINGS

ILLUMINATING ENGINEERING SOCIETY.
Sept. 21-25. Annual convention in Cleveland, Ohio. Secy., Joseph D. Israel, 29 W. 39th St., New York City.

RAILWAY SIGNAL ASSOCIATION.
Sept. 22-24. Annual convention in Bluff Point, N. Y. Secy., C. C. Rosenberg, Times Building, Bethlehem, Penn.

ATLANTIC DEEPER WATERWAYS ASSOCIATION.
Sept. 22-26. Annual convention at New York. Secy., Addison Burke, Philadelphia, Penn.

INTERNATIONAL IRRIGATION CONGRESS.
Oct. 5-9. At Calgary, Alta. Secy., Andrew Miller, Industrial Commissioner, Calgary.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 12-16. Annual convention at Atlantic City, N. J. Secy., E. B. Burritt, 29 West 39th St., New York City.

NATIONAL COUNCIL FOR INDUSTRIAL SAFETY.
Oct. 13-15. Annual "Safety Congress," at Chicago, Ill. Secy., W. H. Cameron, Continental Bank Building, Chicago.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 20. Convention at Los Angeles, Calif. Secy., C. A Lichty, 319 North Waller Ave., Chicago, Ill.

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Oct. 20-23. Annual convention at New Orleans. Secy., James McFall, Roanoke, Va.

AMERICAN ROAD CONGRESS.
Nov. 9-14. Atlanta, Ga. Permanent headquarters, American Highway Association, Colorado Building, Washington, D. C.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 6-9. Annual meeting at Boston, Mass. Secy., Charles Carroll Brown, Indianapolis, Ind.

NATIONAL MUNICIPAL LEAGUE.
Nov. 17-21. Annual meeting at Baltimore, Md. Secy., Clinton Rogers Woodruff, North American Building, Philadelphia, Penn.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Nov. 30-Dec. 5. Annual meeting at Jacksonville, Fla. Secy., Prof. Selskar M. Gunn, Massachusetts Institute of Technology, Boston, Mass.

Association of Iron and Steel Electrical Engineers—The eighth annual meeting of the Association was held in Cleveland, Ohio, Sept. 15. The Secretary is W. T. Snyder, National Tube Co., McKeesport, Penn.

The Cleveland and the Detroit Engineering Societies held a joint inspection trip of Detroit industries on Sept. 12. A banquet was held in the evening. About 150 members of the Cleveland society went to Detroit on the Friday night boat, returning Sunday, Sept. 13.

National Association of Port Authorities—The third annual convention was held in Baltimore, Md., Sept. 8-10, and was well attended by representatives of practically all of the important ports of the country. This association was organized in 1912 to bring together all those who are interested in port financing, management and construction. Necessarily, this is a rather limited field of membership, but in the short time since organization the association has a representation from almost all of the United States ports and, by a revision in the constitution this year, is expecting to take in the other prominent American ports.

The papers presented were as follows:

"Relation of Federal Government to the City in Port Development," Col. William M. Black, U. S. Army, New York; "The Engineer's Part in Port Development," Francis Lee Stuart, Chief Engineer, B. & O. R.R., Baltimore, Md.; "Baltimore Harbor," Oscar F. Lackey, President and Engineer of Harbor Board of Baltimore; "Trade Organizations as a Benefit to the Commerce of the Port," Charles J. Cohen, Philadelphia, Penn.; "The Port of Los Angeles," Maj. Robert R. Raymond, U. S. A., Los Angeles, Calif.; "State Control Over Ports and Waterways," B. F. Cresson, Jr., Chief Engineer, New Jersey Harbor Commission; "The Port of Seattle," Gen. H. M. Chittenden, Seattle, Wash.; "Types of American Port Construction," William Joshua Barney, Consulting Engineer, New York; "Past and Future Freight Handling," J. F. Coleman, Consulting Engineer, New Orleans, La.; "The Port of Boston," Hugh Bancroft, Boston, Mass.; "Lake Ports," Harry C. Gahn, Secretary of Cleveland River and Harbor Commission, Cleveland, Ohio; "Statement Relative to Port Statistics and Facts," T. M. Robertson, Department of Commerce, Washington, D. C.

The following officers were elected for the ensuing year: President, Oscar F. Lackey, President of the Harbor Board of Baltimore; Treasurer, Harry C. Gahn; Secretary, William Joshua Barney, 20 Broadway, New York City. It was decided to hold next year's meeeting at Los Angeles, in the fall of 1915.

Engineering Literature

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REVIEWS AND NOTES

Unique Hydraulic Experiments

REVIEWED BY EMIL KUICHLING*

THE TRANSPORTATION OF DEBRIS BY RUNNING WATER —By Grove Karl Gilbert. Based on Experiments Made with the Assistance of Edward Charles Murphy. Professional Paper 86. Washington, D. C.: U. S. Geological Survey. Paper; 9x12 in.; pp. 259; 92 illustrations.

This interesting publication gives an account of numerous experiments made during the past few years at Berkeley, Calif., for the purpose of ascertaining and studying scientifically the laws that govern the transportation of gravel, sand and other mineral débris by running water. The work was undertaken in connection with the investigation of serious problems caused by the overloading of certain rivers in California with the waste matter of hydraulic mining operations, and its results constitute much-needed additions to our stock of knowledge of physiographic geology and hydraulic engineering.†

Mineral matter is transported by a stream in two ways, the finer particles being held in suspension by the water and the coarser ones moving by sliding, rolling or leaping along the bed of the channel. The suspended material is easily obtained from samples of the flowing water, and much is known as to its quantity; but the amount of heavier matter that travels on the bed cannot be determined in this manner, and little information concerning it is yet available. The primary purpose of the experiments was to learn the laws which control the movement of the bed load, and especially the relation of this load to the stream's slope and discharge and to the size and shape of the material. Four factors were thus introduced besides the velocity of the current, and it is very probable that the width, depth and shape of the channel are additional factors.

Much attention was given to the mode of transportation of the bed material, whether by sliding, rolling or leaping. When the load is small, the bed is molded into ridges or hills, called dunes, which travel downstream, as the current erodes their upstream faces and deposits the material on the downstream faces. With progressive change of conditions tending to increase the load, the ridges or dunes gradually disappear and the channel becomes smooth or even; but with further changes the bed again becomes uneven and a system of dunes will form that appears to travel upstream, owing to erosion on the downstream face and deposition on the upstream face. Both rhythms of débris movement are initiated by rhythm of water movement.

An important distinction is also made between "stream" transportation and "flume" transportation. In the first the load traverses a plastic bed composed of its own material, while in the second, it traverses a rigid bed. "Capacity" and "competence" are also terms used to designate respectively the maximum load of a given kind of material which a given stream can transport, and the ability to start the movement. For example, a stream at its low stage cannot move the débris on its bed, but with increase of discharge the velocity increases until transportation or traction of a certain grade of material begins, and the *discharge* is then said to be competent for that grade; similarly, if the velocity is increased by an increase of slope so as to begin a movement of the bed material, the steeper slope is said to be competent.

The experiments were made mostly in two wooden troughs or channels of rectangular section, 31.5 and 150 ft. long, 1.96 ft. wide and from 1.4 to 2.4 ft. high. The first trough was hinged at its head so as to facilitate changes of slope, while the second was kept horizontal. By means of false bottoms different degrees of channel roughness were secured, and with temporary partitions in the long trough, curved and crooked continuous channels 1 ft. wide were formed. A third trough, 14 ft. long and 0.67 ft. wide, had its woooden sides replaced by plate glass for 3.5 ft. at its middle, and a fourth trough, made of galvanized sheet iron of semi-cylindrical form and 1 ft. wide, was used only in the experiments on flume traction. The results showed that in flumes the transportation of débris in gentle currents is usually by rolling and sliding, and that the capacity of the current increases with the coarseness of the material. In swift currents the principal movement is by leaping, and the capacity increases with the fineness of the grain. The capacity is always increased by increasing the slope and varies on the average with the 1.5 power of the slope; it also varies with the discharge in some irregular ratio.

*Consulting Engineer, 52 Broadway, New York City.

†An abstract of the Professional Paper here reviewed, prepared by the author to preface his volume, was reprinted in "Eng. News" of Sept. 10, 1914, pp. 563 and 564.

An attempt was also made to apply the experimental results to natural streams, but as the flow of a river is a highly complex phenomenon and the transportation of débris by it involves intricate reactions, this work was not accomplished satisfactorily. It was found that the load of transported material is related to the controlling conditions or factors in a very involved manner, and that the law of control for each condition was qualified by all other conditions.

The experience gained from the Berkeley experiments, however, is very useful in carrying out other experiments which may yield more accurate data of the same general class, and it is hoped that the well equipped hydraulic laboratories at Dresden, Karlsruhe and Berlin, where accurate models of river channels are available, will soon be able to furnish observations which will apply more fully to river engineering.

The author has referred to most of the studies of the subject that have been made in our own country and abroad, but cites only the general conclusions reached. The phenomena of subsidence and velocity at which particles of matter settle in still water are discussed very briefly, being regarded only as incidents to transportation; and similarly only a few data are given in regard to the quantity of matter carried in suspension by streams. From lack of reliable observations little information is given about the volume of material that is carried along river beds by traction, although an excellent general discussion of this subject is submitted. In ...e Yuba River at flood stages, the tractional load is given by the author as being equal to the suspended load; at the mouths of the Mississippi, Humphreys and Abbot estimated that the tractional load was 11% of the suspended load; and in contrast thereto, the elaborate study of the loads of the Rhone by Guerard is cited to show that the tractional load was about three times greater than the suspended load. Such enormous variations in estimates and observations indicate clearly the need of many further studies of rivers. It may also be mentioned in this connection that an extensive compilation of data relating to the suspended and tractional load of streams was recently published by Max Singer, C. E., in "Zeitschrift für Gewässerkunde," Vol. 11, 1912, pp. 239-272, and that out of 51 entries only 6 gave the relation between the two loads, the range being from 4.0 to 0.11, as in the foregoing.

Interesting studies were also made at Berkeley of the vertical velocity curves in the experimental channels and the pitot gage used therewith; and although the results of the experiments are mainly applicable to flume transportation, yet the book contains so much other valuable material that it will be an important acquisition to every student of river physics

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CAMBRIA STEEL: A Handbook of Information Relating to Structural Steel Manufactured by the Cambria Steel Co., Containing Useful Tables, Rules, Data and Formulæ for the Use of Engineers, Architects, Builders and Mechanics —Prepared and Compiled by George E. Thackray, Special Engineer, Cambria Steel Co., Johnstown, Penn. Flexible leather; 4x7 in.; pp. x+513; illustrated. $1.25.

The 11th edition of the well known Cambria Steel Handbook has just been published. It appears to contain most of the matter of the previous edition, but has been revised in some particulars and has had considerable new matter added. The new matter consists mainly in the addition of new and heavier sections, extension of the properties of standard railway rails, and the amplification of the tabulation of American municipal building laws. Such standard specifications as have been revised since the previous edition have been changed to meet the new revision.

⁂

A German Pocket-Book for Mechanical Engineers

REVIEWED BY WINSLOW H. HERSCHEL*

TASCHENBUCH FÜR DEN MASCHINENBAU—Herausgegeben von Ing. H. Dubbel. Berlin: Julius Springer. In two parts. Cloth; 5x8 in.; pp. xi + 1482; 2448 text figures and 4 tables. 16 Marks.

In the attempt to cover all branches of engineering, the well known German pocket book, Hütte, has grown to three volumes, but Engineer Dubbel, by confining his attention entirely to mechanical engineering, is able with only one volume of somewhat larger size, to go much more into detail in regard to the subjects considered. He evidently takes Hütte as a model, and aims to give the best methods, rather than a compilation of all the suggestions to be found in engineering literature. It is also his idea that such subjects of general application as mathematics, mechanics and elements of machine design, should be treated very fully, while special types of machinery should be briefly reviewed so as to give any engineer a fair idea of them, since specialists on particular forms of apparatus are acquainted with the books dealing exclusively and in great detail with their machines, and they would never go to a handbook for their information.

This point of view has a far reaching and beneficial influence on the arrangement of the book. The first section, mathematics, is very complete, and includes among subjects not usually found in handbooks, the graphical solution of equations, probabilities, least squares, Fourier series, and an extensive discussion of analytical geometry as applied to engineering problems. Much that is given under mechanics might be looked for elsewhere. Here, instead of under materials, may be found the calculation of springs and tables of permissible stress; the strength of rapidly rotating disks, which are most frequently used in steam turbines; the latest researches on journal friction by Stribeck, Lasche and Heimann; and the graphical method of calculating the stress in crane hooks.

Such fullness in the chapter on mechanics naturally leads to shorter chapters on special machines. Steam engines are covered in about a third of the space usually taken, the bulk of the material coming under thermodynamics in the chapter on mechanics. And yet the chapters on separate machines are very full in regard to details of construction which apply only to those particular types of machines, as in the case of valve gears, under reciprocating engines, or air chambers, under steam pumps. On the other hand, parts which have more general application are placed in the chapter on machine elements, which covers, in addition to the details which may be found in any book on the steam engine, such parts as riveted joints, couplings, gearing, piping, shut-off valves, belts and belt shifters. The application of Mohr's graphical method to the determination of deflection of crankshafts is considered at some length. In fact, throughout the book, free use is made of graphical methods, and of problems to ilustrate the methods given.

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The design of hydraulic turbines occupies considerable space, since this is considered in Germany as the work of mechanical, rather than of civil engineers. Other subjects not usually covered with any degree of completeness in handbooks, are flywheels and governors, hoisting machinery and machine tools.

In the opinion of the reviewer, the book contains as much information as could reasonably be expected in an uptodate handbook for mechanical engineers, well selected and well arranged.

A Manual for Health Officers

PRACTICAL SANITATION: A Handbook for Health Officers and Practitioners of Medicine—By Fletcher Gardner, Captain Medical Corps, Indiana National Guard; First Lieutenant Medical Reserve Corps, United States Army; Health Commissioner of Monroe County, Ind., and James Persons Simonds, Professor of Preventive Medicine and Bacteriology, Medical Department, University of Texas; lately Superintendent Indiana State Laboratory of Hygiene. St. Louis, Mo.: C. V. Mosby Co. Cloth; 6x9 in.; pp. 403; 37 illustrations. $4.

The information and opinions given in this volume are for the most part rational and up to date. By means of concise treatment and the omission of considerable matter common to earlier treatises but, to say the least, not demanding repetition here, the authors have covered a wide range of sanitary topics in relatively brief space.

The book is divided into three parts: (1) Epidemiology, composing half of the volume; (2) General Sanitation, and (3) A brief section on Pathological Materials and some schedules for sanitary surveys and inspection. Most of Epidemiology deals with specific communicable diseases, but there are brief chapters on how to manage epidemics, on isolation and quarantine, hospitals and camps, and on disinfection. General Sanitation includes two or three pages on organization of the sanitary service, several short chapters on reporting vital statistics and 15 chapters on disposal of the dead, school and factory inspection, rats, flies and mosquitoes, soil pollution (privies) sewage and garbage disposal, milk, water, foods and nuisances. The longest of the 15 chapters has about 16 pages; several chapters are 2 to 5 or 6 pages in length.

As has been stated, Epidemiology takes up half of the volume. Such an allotment of space is proper enough if well utilized but as the book seems to have been written for physicians (serving as health officers or practicing medicine) it seems as though too much of this space was given to general notes on specific communicable diseases and not enough to methods of suppression.

Although we are inclined to approve rather than disapprove the brevity of most of the chapters dealing with General Sanitation, we must say that there seems to be some lack of balance in distribution of space here and also a lack of judgment in some of the facts and opinions expressed. Thus, one of the longest chapters under General Sanitation deals wholly with Water Analysis, and this is about all the book contains on water-supply. A chapter of half the length on Sewage Disposal lays too much stress upon the septic tank and subirrigation for isolated houses and mentions no other possible method of treatment.

Perhaps the most remarkable thing about the book, and one which we certainly shall not lay up against the authors, is the absence of not only a chapter but, so far as we can find, even a paragraph on plumbing. The word does not appear in the index.

It seems pertinent to ask, for whom was this book intended, what is its exact aim and how nearly does it serve its intended readers and fulfill its object? The subtitle reads: A "Handbook for Health Officers and Practitioners of Medicine." The preface declares:

> This book was designed to fill a vacancy in literature. Up to the present there has never been a serious endeavor to provide within the covers of a single moderate-priced volume, a plain, nontechnical exposition of the duties of the health officer, written by one experienced in the routine and emergencies of the local sanitary service and familiar with the needs of the local health officer.

After a proper enough disclaimer of originality the Preface continues:

> It aims simply to provide a safe way for the health officer to meet any emergency which may arise. Since sanitary officials in small places out of the reach of libraries are most in need of such a work, and since they are illy paid, the authors have endeavored to provide a book at a moderate price. . . .

It seems only fair to the authors to say that the foregoing statement of their aims partly answers some of our criticisms of their book and to add that they have gone far toward attaining their object. They would have gone still farther toward meeting the needs of medically trained health officers in our smaller American towns, it seems to us, had they cut out still more of the traditional general information about specific diseases and general sanitation and used the space thus saved for a fuller presentation, to repeat once more a few words from their Preface, "of the duties of the health officer" and "safe" means for him to take in meeting "any emergency which may arise." A large percentage of the information presented has only a remote bearing upon the actual duties of the average health officer as he sees and tries to meet them and a still larger percentage will be of little if any use to him in his routine work—much less in emergencies. This only means that the highly commendable work the authors have done in cutting out much of the kind of matter given in earlier treatises for health officers might have been carried further with great advantage, as might the insertion of more material which in plain terms tells the poorly informed average American health officer what he ought to do and how he ought to do it.

TECHNICAL MECHANICS. STATICS AND DYNAMICS—By Edward R. Maurer, Professor of Mechanics, University of Wisconsin. Third edition. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. 353; text illustrations. $2.50.

As a textbook for teaching mechanics, Prof. Maurer's book carries the impress of his long experience in teaching the subject to engineering students. The fundamental principles are stated, demonstrated and impressed on his mind, and applied in the solution of various special problems of technical construction or operation. Out of the great number of such problems met in practice, only a few can be dealt with in any single textbook, and the selection made by an author is apt to determine the reference value, if not the teaching value, of his book.

In Maurer's book, practically the only problems taken up for their own sake are suspended ropes and gyrostatic devices; other applications are used only to illustrate and make more concrete the instruction in the fundamental concepts and principles. In spite of this, the book has considerable reference value to the engineer in practice.

As compared with the first edition (reviewed in these pages, Jan. 14, 1904), the present edition is largely rewritten, and reillustrated, and is equipped with new working examples. The rewriting has been rearrangement as well as rewording of detail explanations; but since there is nothing new in the science of mechanics,

the chief fact to be noted concerning the rewriting is that the author's clear style of discussion characterizes this edition just as strongly as the first.

Two larger changes announced in the preface are that a chapter on Attraction and Stress has been omitted, and a treatment of the gyrostat—not a very convincing treatment, by he way—has been added.

British Shop Costs and Production

REVIEWED BY ROSSITER R. POTTER*

ENGINEERS' COSTS and Economical Workshop Production—By Dempster Smith, M. I. Mech. S., Lecturer in Mechanical Engineering, Manchester Municipal School of Technology, and Philip C. N. Pickworth, M. Sc. Tech. [The "Mechanical World" Series.]. Manchester and London: Emmott & Co., Ltd. Cloth; 6x9 in.; pp. xi + 248; 32 text illustrations. 4½ Shillings, net.

From an American point of view, the value of this book is considerably restricted due to the differences between American and British industrial conditions and practice. The first four or five chapters on specifications, grades and prices of metals (chiefly of iron, steel and copper) apply, of course, simply to British conditions. The middle section, taking up the subject of machine-shop production, will be the most interesting to American readers, and in particular Chapters VI and VII on wage systems and shop organization and Chapter VIII, which includes a condensed discussion of Taylor's experiments with cutting tools and of the Berlin and Manchester experiments.

Chapters VIII to XII are based on a series of articles published in the *Mechanical World* some three years ago. Of these, Chapters X and XI give formulas for computing "standard times" for a few machine and hand operations. The times obtained by the use of these formulas, however, seem to be much too large if the work is to be done on a piecework or bonus basis. Much depends, of course, upon the nature of the piece to be worked upon. The formulas may be correct for the particular class of work the authors had in mind, but this they do not clearly define. Any engineer or manager who accepts these or any other general formulas at their face value and uses them to establish standard times for piecework in his own shop will be quite apt to come to grief.

The last part of the book takes up cost keeping, with a couple of chapters on British railway rates and on the shipment of goods from British ports. The chapters on cost keeping are decidedly elementary and of little use except perhaps to give a general idea of the subject to one entirely unfamiliar with it. In general, this book will not be of much importance to engineers or managers on this side of the Atlantic. But ignoring for the moment the present unsettled conditions due to the European war, the information on British metal markets, shipping methods and wage rates would be of interest to anyone contemplating a connection with some English engineering works.

SOME ENGINEERING PHASES OF PITTSBURGH'S SMOKE PROBLEM—Smoke Investigation Bulletin 8, Mellon Institute of Industrial Research and School of Specific Industries. Pittsburgh: Penn.: University of Pittsburgh. Paper; 6x9 in.; pp. 193; illustrated.

The eighth bulletin in the Mellon Institute series, relating the progress of the Pittsburgh studies and smoke prevention in general, presents the first specific figures on the trouble makers in Pittsburgh. The bulletin gives a brief review of the agitation for improvement, summarizing the evidences of trouble, outlines some contributing causes of the evil like quality of fuel and local topography, and classifies the sources of smoke. All this, a little less than half the book, is preliminary to the discussion of a mechanical engineer's survey of stationary boiler plants. Here are described typical constructions and operating results with (1) hand-fired; (2) chain-grate stoker; (3) front-feed stoker; (4) side-feed stoker; and (5) underfeed stoker plants. The relative undesirability, as there operated, ranged in the order (3), (1), (2), (4), (5). One notable feature of the bulletin is a series of Pittsburgh views, taken from identical positions on clear and smoky days.

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A New Edition of Moyer's Steam Turbine

REVIEWED BY H. E. LONGWELL*

THE STEAM TURBINE: A Practical and Theoretical Treatise for Engineers and Designers, Including a Discussion of the Gas Turbine—By James Ambrose Moyer, M. Am. Soc. C. E., Professor in Charge of Department of Mechanical Engineering, Pennsylvania State College. Second edition, revised and enlarged. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 376; 225 illustrations. $3.50, net.

The fact that the publishers have been encouraged to put out a second edition of a technical book is, as a general proposition, the best kind of evidence that it is a useful work. The first edition of Professor Moyer's treatise was published in 1908, and was reviewed in ENGINEERING NEWS of March 18, 1909.

This second edition does not differ much from the original, except by way of some additional pages of descriptive matter, and the insertion of a number of practice problems. The first six chapters are unchanged except for a couple of small additions to Chapter II, on the Elementary Theory of Heat, and Chapter III, on Nozzle Design. Chapter VII, on Commercial Types, has been augmented by 14 pages of new text and illustrations. Chapter IX, on Low-Pressure Turbines, has been enlarged to twice its original size, and gives a much more comprehensive discussion of this machine and the circumstances which justify its use.

Two new chapters have been inserted which treat briefly of Mixed-Pressure Turbines and Bleeder or Extraction Turbines—developments that were in the embryonic stage at the time the first edition of the book was published. The chapter on Marine Turbines has been enlarged from two pages in the first edition to eight pages in the present edition, and is still very brief, considering the enormous development that has taken place in this application of the steam turbine during the past eight years.

The final four chapters, dealing with Turbine Economics, Stresses in Rings, Drums and Disks, Gas Turbines and Electric Generators, are practically identical with the corresponding chapters in the first edition. In view of the considerable advance in high-speed generator design and construction in recent years, it would seem that the author might have enlarged a little on this subject.

An appendix of six pages of practice problems enhances the value of the work as a textbook. An unusually well engraved entropy-total heat diagram, on a conveniently large scale, accompanies the book.

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The subtitle, "A Practical and Theoretical Treatise for Engineers and Designers," is a trifle pretentious if the author refers to engineers who design and construct steam turbines. The work is hardly comprehensive enough to warrant this characterization. It treats the subject in a conventional manner, and is undoubtedly an efficient elementary textbook for students, or for power-plant engineers, who, while not wishing to specialize on steam turbines, may find it advantageous to have a good general knowledge of their theory, construction and practical application.

Engineering Geology

ENGINEERING GEOLOGY—By Heinrich Ries, Professor of Economic Geology, Cornell University, and Thomas L. Watson, Professor of Economic Geology, University of Virginia, and State Geologist of Virginia. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xxvi+672; 175 illustrations. $4 net.

Many, if not all, the larger colleges offer no end of "courses" in geology, but too many engineering schools either fail to provide a course in geology suited to the needs of their students or else leave the ordinary student no time to take such a course if one is offered. This is unfortunate, because of the many relations of geological knowledge to sound engineering design and construction, as the nature of rocks available for road making, or to serve as foundations for heavy structures or to be pierced by tunnels.

A book which treats of geology chiefly from an engineering viewpoint is, therefore, a most welcome addition to our engineering literature, especially when that book is so complete and authoritative as to serve not only for a college textbook, but to form a valuable reference work for any engineer's library. As Dr. Ries is already known to many engineers through his splendid book "Economic Geology," and his books on building stones and clay products, little more need be said of the merits of the book before us.

A synopsis of the contents follows:

Rock-forming minerals, essential principles of crystallography (45 pp.); the general characteristics, mode of occurrence and origin of rocks (100 pp.); the structural features of metamorphism of rocks with references to engineering experience on the Catskill and Los Angeles aqueducts, etc. (68 pp.); rock weathering and soils, which a topographical engineer should understand to fully appreciate topographical features of the maps he draws (29 pp.); surface waters (rivers) including the geology of runoff and stream flow, erosion, transportation of sediment, delta formation, etc. (51 pp.); underground waters, treated from every viewpoint as sources of water-supply (47 pp.); landslides and their effects, (16 pp.); wave action and shore currents and their relation to coasts and harbors (38 pp.); the origin and relation of lakes to engineering work (18 pp.); the origin, structure and economic bearing of glacial deposits, containing much material of interest in connection with subsurface construction (15 pp.); building stone, their kinds, sources, properties and uses of various North American stones (64 pp.); limes, cement and plaster, their composition, sources, manufacture and properties (17 pp.); clay and clay products, their properties and uses (17 pp.); coal series, kinds of, origin, distribution in the United States, uses, etc. (35 pp.); petroleum, natural gas and other hydrocarbons, properties, occurrence, including solid and liquid bitumens (25 pp.); road foundations and road materials, geological conditions which affect permanence and stability, kind and character of rock, gravel and sand (27 pp.); ore deposits, nature and occurrence of all the more important metal ores, but not a detailed discussion of their distribution (42 pp.)

We have given the synopsis at some length because a glance through it will show the completeness of the book. Each chapter includes a list of references to more detailed information.

The only objection to this book is its weight, not metaphorically speaking, but actually, for it weighs upward of 3 lb. We have noted this objection to some engineering books before. We believe it is a serious objection, for most engineers are obliged to carry their working library from place to place, and even a few such books constitute too great a load for the average trunk. Even if the book is not to be carted about the country, it is still inconvenient, for no one wishes to hold a 3-lb. weight when reading.

DAS SPIEL DER KRAFTE IM VERBUNDBALKEN; Eine Darstellung der Lehre vom Verbund, von der Spannungsverteilung und Ermittlung in auf Biegung beanspruchten Eisenbetonkörpern—Von Georg Fischer, Regierungsbaumeister, a.D. in Posen. Lissa-in-Posen, Germany: Oskar Eulitz. Pasteboard; 7x10 in.; pp. 77; 53 text figures. 6 Marks.

Regarding the reinforced-concrete beam as an arch in its central portion and a beam with concrete and steel jointly in tension in the end portions, the author locates the stress transfer from concrete to steel mainly in the region near the ends of the arch, instead of finding maximum bond stress at the ends as is usually thought. He further reasons that end anchorages, deformed bars, etc., are either useless or unnecessary expedients. He prefers designing beams for the range below tensile rupture of the concrete, limiting the steel stress to the limiting safe elongation of the concrete; the elastic ratio is still to be determined by test, he declares. In such design, the tensile strength of the concrete is to be counted in figuring the moment.

A new good-roads periodical under the name of "Dependable Highways" has made its appearance. This is the official bulletin of the National Paving Brick Manufacturers' Association, published by the Secretary of the Association, Engineers' Building, Cleveland, Ohio. It is sent gratis to municipal officials, engineers, highway commissioners, contractors and manufacturers, and doubtless to any engineer requesting to be placed on the mailing list. The paper is, of course, devoted chiefly to brick roads and pavements, but it is announced that attention will be given to other phases of road work. Indeed the first issue, dated August, 1914, contains an article by J. T. Fetherston, Commissioner of Street Cleaning, New York City, on "Litter Prevention as a Street Cleaning Factor," which displays an intention to include other than articles exploiting brick-road construction. It was announced at the convention of the Society held in Buffalo, Sept. 9, 10 and 11, that the bulletin is already on a self-supporting basis.

The new specifications for brick pavements of the National Paving Brick Manufacturers' Association have been issued in booklet form and may be obtained by addressing the Secretary, Will P. Blair, Engineers Building, Cleveland, Ohio. The present booklet represents two years' work of a committee appointed to revise and draft new specifications. The specifications cover excavation, grading, drainage, and curbing, as well as pavement and foundation. The clauses in the specifications covering the testing of materials are adopted chiefly from those proposed by the committee of the American Society for Testing Materials.

Bituminous expansion joints at the curbs are specified, but transverse expansion joints are expressly prohibited. Cement grout and sand fillers only are provided for; the association does not recommend or advise bituminous filler

for brick pavements. The specifications for foundations cover concrete, broken stone, old gravel or macadam and No. 2 paving brick. There are two distinct sets of specifications, one for city pavements and one for country roads.

LINK MOTIONS, VALVE GEARS AND VALVE SETTING: A Practical Treatise Which Explains the Mysteries of Valve Setting. Shows the Different Valve Gears in Use, How They Work and Why. Piston and Slide Valves of Different Types are Illustrated and Explained—By Fred H. Colvin, Associate Editor "American Machinist." Third edition, revised and enlarged. New York: Norman W. Henley Publishing Co. Cloth; 4x6 in.; pp. 101; 45 text illustrations. 50c.

Three new chapters have been added to this book, which, in other respects, is the same as at the time of its first appearance more than ten years ago. The new matter relates to the Walschærts, the Baker, and the Southern locomotive-valve gears. The increasing size of locomotives has led to a wide application of the Walschærts gear, which is placed on the outside of the connecting-rod in an accessible position. The other two valve gears mentioned are not extensively used, but their existence justifies their description.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

ANNUAL REPORT OF NEW YORK STATE ENGINEER AND SURVEYOR. J. A. Bensel (Albany, N. Y.), 1913. Vol. 1. Cloth; 6x9 in.; pp. 489; illustrated.

ASSOCIATION OF ONTARIO LAND SURVEYORS—Annual Report and Proceedings of Toronto Meeting, Feb. 17-19, 1914. Toronto: L. V. Rorke, Secy.-Treas. Paper; 6x9 in.; pp. 216.

BOARD OF WATER SUPPLY OF THE CITY OF NEW YORK (Municipal Bldg.)—Eighth Annual Report, Jan. 1, 1914, Accompanied by Report of the Chief Engineer. Paper; 6x9 in.; pp. 305; illustrated.

FOUNDATIONS: A Short Text-Book on Ordinary Foundations, including a Brief Description of the Methods Used for Difficult Foundations—By Malverd A. Howe, M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vii + 110; 55 text figures. $1.25, net.

HANDBOOK OF TABLES AND FORMULAS FOR ENGINEERS—Compiled by Clarence A. Peirce, Instructor in Power Engineering, with Mathematical Sections by Walter B. Carver, Assistant Professor of Mathematics; Cornell University. New York and London: McGraw-Hill Book Co., Inc. Flexible leather; 4x7 in.; pp. x + 168; illustrated. $1.50, net.

HEAT ENGINES; Steam, Gas, Steam Turbines and Their Auxiliaries—By John R. Allen, Professor of Mechanical Engineering, and Joseph A. Bursley, Junior Professor of Mechanical Engineering; University of Michigan. Second edition, thoroughly revised and entirely reset. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xiii + 320; 185 illustrations. $3, net.

IOWA STATE DRAINAGE ASSOCIATION—Proceedings of Annual Meeting, Fort Dodge, Iowa, Feb. 25-26, 1914. Ames, Iowa: M. F. P. Costelloe, Secy.-Treas. Paper; 6x9 in.; pp. 93. 25c., postpaid.

IRON ORES, Their Occurrence, Valuation and Control—By Edwin C. Eckel, Assoc. M. Am. Soc. C. E. New York and London: McGraw-Hill Book Co., Inc. Cloth; 6x9 in.; pp. xvii + 430; 66 illustrations. $4, net.

LACKAWANNA STEEL COMPANY'S HANDBOOK for Engineers, Architects and Builders—Containing General Information, Together with Diagrams, Dimensions and Weights of Structural Steel Sections, Special Shapes, Merchant Bars, Steel Sheet Piling, Standard Heavy and Light Rails, Track Accessories, etc., Manufactured by the Company, Buffalo, N. Y. 1915 Edition. Flexible leather; 4x7 in.; pp. 456; illustrated. $2.

THE MECHANICAL PROPERTIES OF WOOD; Including a Discussion of the Factors Affecting the Mechanical Properties and Methods of Timber Testing—By Samuel J. Record, Assistant Professor of Forest Products, Yale University. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. xi + 165; 51 illustrations. $1.75, net.

MINERAL RESOURCES OF THE UNITED STATES (1912)—Part I, Metals. Part II, Nonmetals. Washington, D. C.: U. S. Geological Survey. Cloth; 6x9 in.; pp. 1079 and 1218.

MODERN TUNNELING, with Special Reference to Mine and Water-Supply Tunnels—By David W. Brunton and John A. Davis. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vi + 450; 80 text figures. $3.50, net.

MONTANA INSTITUTE OF MUNICIPAL ENGINEERS—Proceedings of Annual Meeting, Great Falls, Mont., Jan. 19-21, Vol. I. Bozeman: C. C. Widener, Secy.-Treas. Paper; 6x9 in.; pp. 109.

NEW JERSEY STATE BOARD OF HEALTH (Trenton, N. J.)—Annual Report for 1913, and Report of the Bureau of Vital Statistics. Cloth; 6x9 in.; pp. 831; illustrated.

OUR MINERAL RESERVES; How to Make America Industrially Independent—By George Otis Smith. Bulletin 599. Washington, D. C.: U. S. Geological Survey. Paper; 6x9 in.; pp. 48.

THE POLLUTION OF BOUNDARY WATERS—Progress Report of the International Joint Commission (Jan. 16, 1914) on the Reference by the United States and Canada as to [Whether or Not Such Pollution Extends Across the Boundary in Contravention of the Treaty of Jan. 11, 1909, and If So, in What Manner or by What Means Is It Possible to Prevent the Same]. Washington, D. C.: The Commission. Paper; 9x12 in.; pp. 388; illustrated.

PUMPING BY COMPRESSED AIR—By Edmund M. Ivens, Jun. M. Am. Soc. M. E. New York: John Wiley & Sons, Inc. London: Chapman & Hall, Ltd. Cloth; 6x9 in.; pp. vi + 244; 106 text figures. $3.

RAILROAD AND CANAL COMPANIES OF THE STATE OF NEW JERSEY—Annual Statements, Together with Report of State Director of the United New Jersey R.R. & Canal Co., 1913. Trenton, N. J.: E. I. Edwards, Comptroller of the Treasury. Cloth; 6x9 in.; pp. 251.

REPORT OF THE COMMISSIONERS OF THE STATE RESERVATION AT SARATOGA SPRINGS, 1914 (Saratoga Springs, N. Y.)—Paper; pp. 109; illustrated.

Several special reports on noted European medical baths and springs are included with the stated report of the Commission. One of these special reports is by Charles G. Anthony, Consulting Engineer to the Commission. It contains some interesting notes on the piping and pumping of mineral waters, a phase of water-supply information seldom treated in print.

REPORT ON CANADIAN IRRIGATION, 1913—Part VII of the Annual Report. Ottawa, Canada: Department of the Interior. Paper; 7x10; pp. 179; illustrated.

SCALES for Ascertaining the Dimensions of Pipes, Drains and Sewers—By C. E. Housden, late Superintending Engineer, Public Works Department, India, and Sanitary Engineer to the Governments of Burma and Eastern Bengal and Assam. New York and London: Longmans, Green & Co. Linen; 5x7 in.; pp. 16. 60c., net.

THE STORY OF THE NATIONAL FIRE PROTECTION ASSOCIATION and List of Its Publications. Boston, Mass.: Franklin H. Wentworth, Secy.-Treas., 87 Milk St. Paper; 6x9 in.; pp. 11.

UNIT CONSTRUCTION COSTS From the New Smelter of the Arizona Copper Co., Ltd.—By E. Horton Jones. New York and London: McGraw-Hill Book Co., Inc. (Republished by Special Arrangement with the American Institute of Mining Engineers.) Cloth; 6x9 in.; pp. 1497-1649; illustrated. $2, net.

USEFUL MINERALS OF THE UNITED STATES—Compiled by Samuel Sanford and Ralph W. Stone. Washington, D. C.: U. S. Geological Survey. Bulletin 585. Paper; 6x9 in.; pp. 250.

Under each state the minerals found therein are listed alphabetically and the locations where found in the state are given.

DIE VIRTUELLEN LAGEN DER EISENBAHNEN: Die Vergleichslängen im Allgemeinen. Die Methoden der Verschiedenen Autoren zur Bestimmung virtueller Entfernungen. Die virtuelle Länge hinsichtlich der Transportkosten, sowie der Transport und Bahndienstkosten im Besondern, die Beziehungen derselben zu andern Vergleichslängen und ihre allgemeine Anwendung—Von Dr. sc. techn. Carl Mutzner, Ingenieur Zurich and Leipzig: Leemann & Co. Paper; 7x10 in.; pp. 173; illustrated. 6 Francs.

The author discusses various kinds of equivalent or virtual length of railway line, i.e., the length of level tangent whose operating characteristics are the same as those of the actual line. The comparison may be based on integrated tractive effort, or on cost of operation, or on some other quantity. An appendix discusses lines of uniform virtual grade, or uniform resistance.

WATER-SUPPLY PAPERS, U. S. GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.

Surface Water Supply of the United States, 1912:

No. 321; Part I. North Atlantic Coast Basins—By C. C. Babb, C. C. Covert and J. G. Mathers. Pp. 240.

No. 325; Part IV. Upper Mississippi River and Hudson Bay Basins—By A. H. Horton, W. G. Hoyt and H. J. Jackson. Pp. 193.

No. 328; Part VIII. Western Gulf of Mexico Basins—By W. W. Follett, Robert Follansbee and G. A. Gray. Pp. 121.

Water Resources of Hawaii, 1912—By C. H. Pierce and G. K. Larrison. No. 336. Pp. 392.